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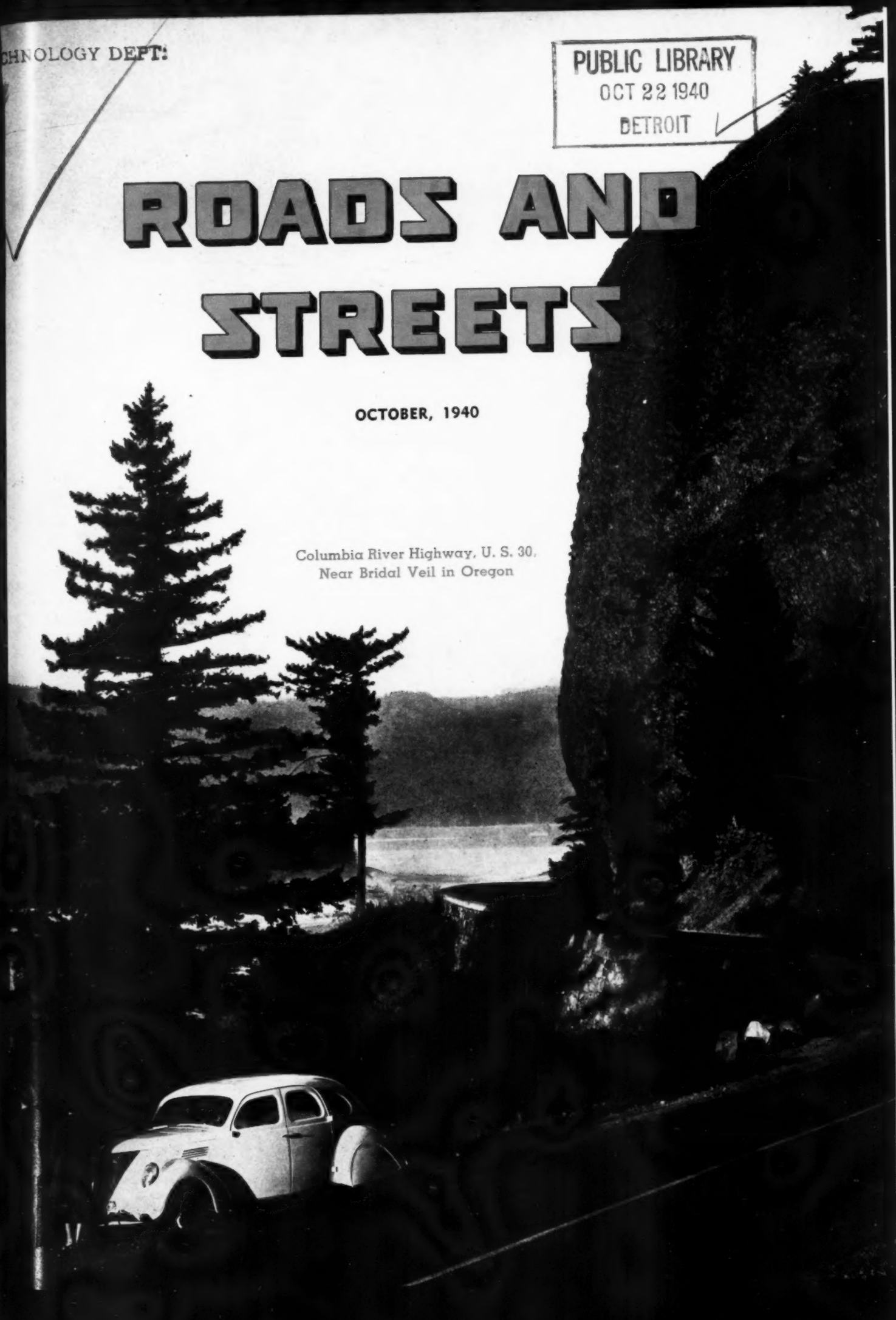
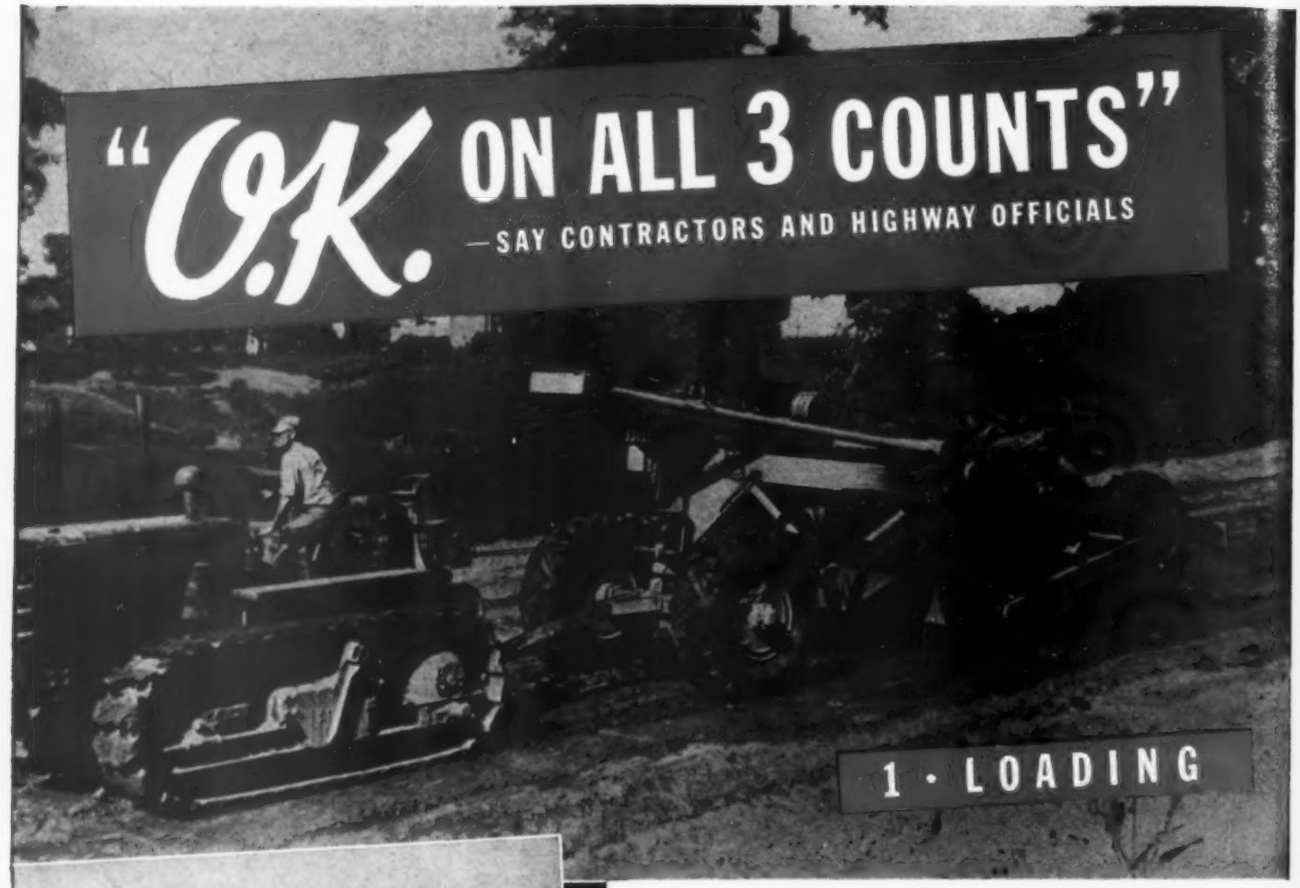


Columbia River Highway, U. S. 30,
Near Bridal Veil in Oregon



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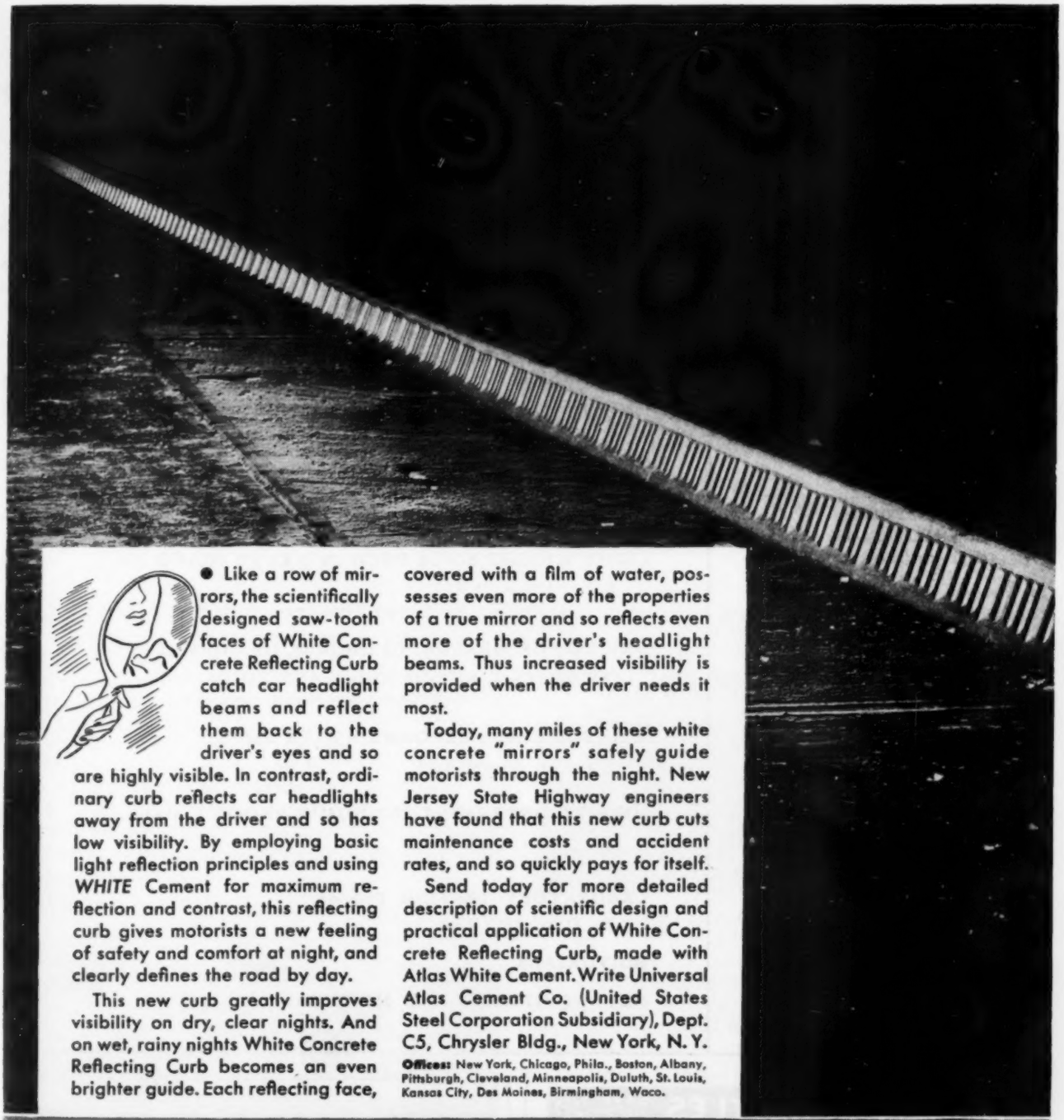

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ROADS and STREETS

Vol. 83, No. 10 October, 1940

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VARIABLE CONSTRUCTION METHODS ON TWELVE MILE PROJECT

Hydraulic Grading, "High Line" Cable Way, and Foundation Settlement Among Features

By VICTOR J. BROWN
Publishing Director,
ROADS AND STREETS

RELOCATION of about 12 miles of the Pacific Highway, U. S. 99, north of Vancouver, Washington, eliminates the worst part of that road left in the state. The project is divided into five contracts with a supplemental contract on one of the bridge jobs. Features on the project are the dredged roadway fills, the square bridge with skewed piers, the channel change, and the fluid foundation under part of another bridge. The roadway is being graded to accommodate a dual highway. The proposed slab on either side of the 4 ft. center strip will be 21 ft. wide. Contracts for this work have not been let.

Shoulders in cut are designed 7 ft. wide and on fills, 9 ft. wide. The inslopes of cuts are 6 ft. long on 3:1 slope for cuts over 4 ft. deep. For the shallower cuts the inslopes are 4:1 and 12 ft. long with 4:1 back slopes. Backslopes on the deeper cuts are as follows:

5 ft. to 10 ft.	3:1
10 ft. to 15 ft.	2:1
15 ft. and over	1½:1

The side ditches in shallow cuts are 3 ft. deep. Fill slopes vary, also, from 4:1 to 1½:1, depending upon depth of fill and character of soil. On the hydraulic fill section the fill slopes are 3:1 except where high water of the river is

Fig. 1.—Loading a Kuckenberg Scraper Outfit. A Pusher Speeds the Operation

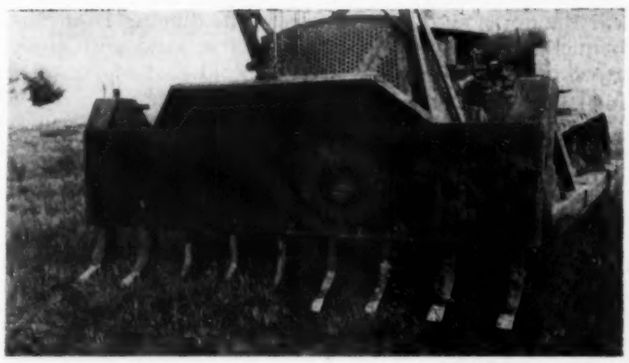


Fig. 2.—Grubbing Dozer on Kuckenberg Job. Note Heavy Rooting Teeth

Fig. 3.—Driving 12 in. by 53 lb. Steel H-Beam Piling on Hoffman's Job. These Drive to Refusal at About 100 ft. Depth

expected to encroach where they are made 10:1. In the field, the engineer varies some of the cut slopes to fit the ground.

A channel change with a rip rapped slope is located near the north end of the project. The digging from this channel change is nearly a pure coarse sand with some gravel occasionally and is used to build part of the relocated roadfills.

One of the large bridges crosses the Lewis River a short distance south of Woodland, the other one crosses the East Fork of the Lewis River in the vicinity of La Center.

From south to North the contracts are as follows:

1. No. 2629—Kozy Kamp to Pioneer (Grading).
2. No. 2472—Pioneer to East Fork, Lewis River
2. No. 2472—Pioneer to East Fork, Lewis River (Grading).
3. No. 2473—East Fork, Lewis River Bridge and Approaches. (Bridge Contract.)
4. No. 2567—East Fork Lewis River to North of Woodland (Grading).
5. No. 2559—Lewis River Bridge (Bridge Contract).

Kuckenberg Contract

KOZY KAMP TO PIONEER

In this 3.76 mi. section Class D excavation is that required for drainage channel changes to culverts. Overhaul is allowed in two parts; station-yards and mile-yards. The station-yard overhaul is that excavation hauled over 600 ft. and under the lower limit calculated for the mile-yard overhaul. The mile-yard unit begins at "that point" where one half of the cubic yard price equals ("that point"—600) times the station-yard price of overhaul. The formula is set up in the standard specifications.

For the clearing and grubbing work the contractor, Kuckenberg Construction Co., 11,104 N. E. Holman St., Portland, Ore., is using a Caterpillar D8 tractor equipped with an Issacson box type, toothed bulldozer. Dynamite is used for shattering the large stumps. He windrowed the brush and trees down the center of the cleared right-of-way to dry where he could then burn them.

The soil on this stretch is a silty clay for the most part with some silty loam. Cuts will average about 8 to 18 ft. and fills from 10 to 25 ft. in height except one big fill of 52 ft. height at the deepest part. There is no rolling or watering required; satisfactory density is being obtained, it is stated, by the compactive effect of vibration from the crawler tractors combined with the load of the scrapers. A bulldozer operates over the fill to spread the dumped soil in thin layers.

Kuckenberg is using the following equipment:

1—Dozing grubber for clearing and grubbing, mounted on a 75 Caterpillar tractor.
1—Caterpillar D8 hauling a 12-yd. Le Tourneau and a 15-yd. Le Tourneau scraper in tandem. Each one is built up with side boards to haul about 3 yds. more
1—Caterpillar D8 with two 20-yd. Le Tourneau scrapers built up to haul 23 yds.
1—Caterpillar D8, hauling a 12-yd. scraper, alternating on a ripper.
1—Allis-Chalmers HD14 tractor equipped with pusher plate for helping to load scraper.
1—Bucyrus-Erie 20B dragline operating a ½-yd. bucket and as a crane for setting concrete culvert pipe.
1—Motor grader.

Fig. 4.—View Looking Over Extension Work from Floor of Completed Section of Approach. Other Footing Holes Can Be Seen. Men In Foreground Are Adjusting Pile Driver. Concrete Plant In Background

Fig. 5.—Showing How Trestle Columns Were Cut on Hoffman Contract to Jack Approach Deck Back to Grade. These Will Be Grouted With Concrete Scabs

For completing the job which includes culvert construction, gravel backfill of drain tile, slope treatment, roadbed ballast, and crushed stone surfacing for traffic service, the contractor has 210 working days. He must average about 1,600 cu. yds. a day during working weather to complete the job on time. At the time the writer visited the job he was making a round trip in 8 to 10 minutes on about a 700 ft. haul. Loads averaged about 95 per cent of capacity. Two 7-hr. shifts keep the outfit moving during the day.

Following is a summary of the principal estimated quantities and bid prices:

Item	Unit	Est. Quan.	Bid Price	Amount
Clearing	Acre	37.7	$100.00	$ 3,770.00
Grubbing	Acre	24.9	100.00	2,490.00
Excavation, Unclassified, including haul of 600 ft.	Cu. Yd.	323,000	0.12	38,760.00

Fig. 6.—Resident Engineer Mills, Supt. J. A. Wall, and Inspector S. D. Retzing on Hoffman Job. In Reality, Wall Smiles Quite a Bit

Excavation, Structure, including haul of 600 ft.	Cu. Yd.	3,170	0.50	1,585.00
Excavation, Class "D", including haul of 600 ft.	Cu. Yd.	3,800	0.50	1,900.00
Overhaul on above materials	Sta.-Yd.	99,830	0.01	998.30
Overhaul on above materials	Mi.-Yd.	81,660	0.10	8,166.00
Slope treatment	Lin. Ft.	33,470	0.05	1,673.50

This job, like the entire project, being a Federal Aid contract is subject to the Federal Aid Special Provisions of February 17, 1937, and later revisions, regarding employment of labor.

Blake Contract

PIONEER TO EAST FORK, LEWIS RIVER

This 4.5 mile section of the project was completed last fall by the Harold Blake Estate, Contractor, Portland, Oregon. The soil for most all of the project was a silty or sandy yellow clay. In some places seams of gravel were encountered and in one place 6,720 cu. yds. of rock.

The maximum grade on this section was 5 per cent. The cross section was graded 29 ft. wide from center line to shoulder in cuts and 31 ft. wide from center line to shoulder in fills, except that shallow fills were built out to 33 ft. 9 in. and sloped 4:1 to the natural ground. All curves were superelevated and widened according to the Washington standard, the same as applies to all state work.

Following is the summary of the principal estimated quantities and bid prices on this section:

Item	Unit	Est. Quan.	Bid Price	Amount
Clearing	Acre	24.3	$110.00	$ 2,673.00
Grubbing	Acre	11.7	110.00	1,287.00
Excavation, Class "A", including 600 ft. haul	Cu. Yd.	294,370	0.145	42,683.65

Fig. 7.—Closeup of Dredge Cutting Channel Change

Excavation, Solid Rock, including 600 ft. haul	Cu. Yd.	6,720	0.60	4,032.00
Excavation, Structure, including 600 ft. haul	Cu. Yd.	3,050	0.90	2,745.00
Excavation, Class "D", including 600 ft. haul	Cu. Yd.	1,610	0.90	1,449.00
Overhaul, on above materials	Sta.-Yd.	149,200	0.01	1,492.00
Overhaul, on above materials	Mi.-Yd.	40,240	0.10	4,024.00
Slope treatment	Lin. Ft.	31,045	0.09	2,794.05

Hoffman Contract

EAST FORK LEWIS RIVER BRIDGE AND APPROACHES

In this contract, besides the steel high through truss bridge with concrete floor, 48 ft. curb to curb, and the continuous reinforced concrete T-beam spans on concrete trestle bents with a short cantilever span on the ends, there was some clearing, grubbing and a little grad-

Fig. 8.—Discharge End of Dredge Pipe Building Fill to Close Channel Loop Cut Off from River

ing. The contract was executed on Nov. 19, 1939, allowing 270 calendar days for completion. However, a supplemental contract was made for an extension of the original south approach after the grading backfill to the completed trestle had acused a foundation settlement of about 5 in.

The original plan called for a 248 ft., 8-panel through steel truss supported on piers 249 ft. c-c. and flanked by 36 ft., 34 ft. and 10 ft. reinforced concrete T-beam spans on the north end, and 59 ft., 57 ft. and 18 ft. reinforced concrete T-beam spans on the south end. When the 40 ft. fill was placed against the end of the south approach, the trestle settled as stated. As a corrective measure the fill was all removed to the natural ground, and the end trestle bent raised. This was done by cutting the end row of

Fig. 9.—Showing Soil Dikes Thrown Up By Drag Line and Bulldozer for First Lift of Hydraulic Embankment. Dredge Fill is Just Beginning

columns, jacking up the deck and welding pieces of H-beam and reinforcing rods in place. These will be grouted in and covered with a concrete scab. A space of about 12 in. high was cut out to accommodate the H-beams.

Because of the fluid conditions below the foundation a trestle extension was designed for the south end to replace the fill originally planned. It consists of a 23 ft. 6 in. cantilever span to fit against the 18 ft. cantilever on the original end span. Next toward the south are two 73 ft. and three 65 ft. spans with a 22 ft. 6 in. cantilever span on the south end. They are of modified continuous T-beam design similar to the original spans and carried

Fig. 10.—View of Waste Water Outlet in Soil Dikes. Pipes in Foreground Are Continued Back to River. Timbers Are Raised As Fill Height Increases

Fig. 11.—Another View of Waste Water Outlet Weir. Note Pipe Line Stretched Along Dike at Right

on reinforced concrete trestle columns supported by a footing. On the two bents just south of the one that settled, 12 in. by 53 lb. steel H-beams are being driven as piling to bed rock. These piles are being driven in two lengths. First a 68 ft. length is driven. Then a 40 ft. length is splice-welded onto these and the 108 ft. steel piles driven to refusal. Jetting with two nozzles, one on each side of the web, is necessary to assist in driving these long piles.

At the time the writer visited this job, the north approach trestle was finished, the steel through truss was finished and work was in progress on the extension of the south approach. For driving the piles Hoffman was using a McKiernan-Terry 10B3 steam hammer with a 3,000-lb. ram. An old Bucyrus-Erie diesel engined, long boom crane handled the piling from storage to the steam-powered stiff leg derrick that carried the pile driver leads. The stiff leg operated on the original south approach.

The two channel footings, over the unstable substrata of fluid material, are supported by 38 piles per footing

Fig. 12.—Tandem Scraper Operation On Sub-Contractor Pennepacker's Job. Side Slopes Are 1 to 1 in. Silty, Sandy Soil. Motor Grader Trims Back Slopes

(or per bent). As stated, these steel piles were being spliced and driven to refusal, i.e., to bed rock. Each hole is cofferdammed with 3 in. by 10 in. tongued and grooved wood sheet piling.

The last four bents have footings bedded on rock at elevations — 19.0, + 7.0, — 18.0, and + 26.0 ft., respectively. One of these holes is sheeted with 40 ft. Carnegie steel sheet piles held in place with 12 in. by 20 in. wales and struts. These were used because this hole is

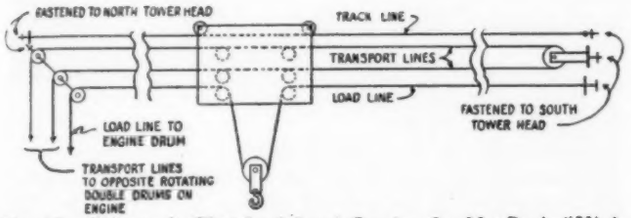

FASTENED TO NORTH TOWER HEAD
TRACK LINE
TRANSPORT LINES
LOAD LINE
FASTENED TO SOUTH TOWER HEAD
LOAD LINE TO ENGINE DRUM
TRANSPORT LINES TO OPPOSITE ROTATING DOUBLE DRUMS ON ENGINE

Fig. 13.—Schematic Sketch of Load Carrier On MacRae's "High Line"

at a point where the bedrock dips sharply down toward the stream and the soil is saturated from the hill above. For excavating foundation holes, a Williams ¾-yd. or the 1-yd. clam shell bucket was used as needed with the Bucyrus-Erie crane.

Concrete Plant.—On the south bank near the sand and gravel stock piles, Hoffman built a timber concreting plant. The aggregate bins are built together, with a dividing wall, for a 70 yd. capacity for gravel and a 60 yd. storage capacity for sand. The gravel compartment is 12 ft. by 14 ft. by 12 ft. high. The sand compartment is 10 ft. by 14 ft. by 12 ft. high. Johnson batchers are suspended below to feed the hopper of a 21-S Loehring mixer. Concrete will be buggied out on ramps or trucked to the footings, columns, and deck. Trucks will be used for footings and as high as they can reach in column forms. The whole 387 ft. extension will be poured continuously. About 30 hours continuous pouring will be required.

One thing which the writer noticed about this job was the safe working conditions built into the construction

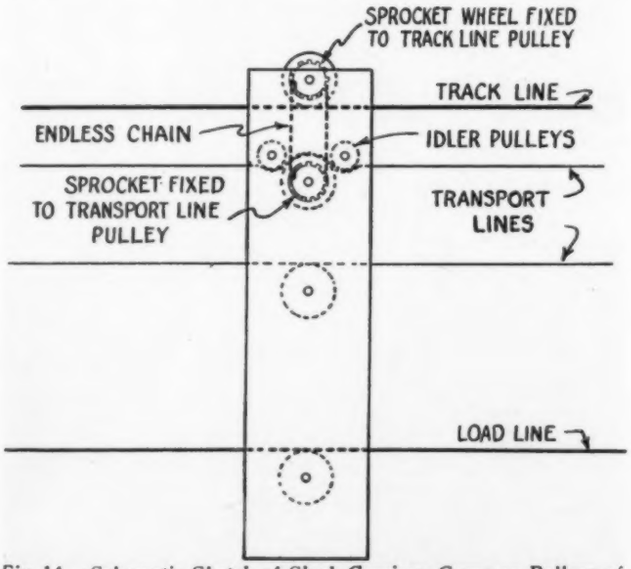


Fig. 14.—Schematic Sketch of Slack Carriers. Gears on Pulleys of One Carrier Are Same Size. Gears in Other Carriers, However, Are Different Sizes in Order to Give Variable Travel Between Carriers and Thus Space Equally Between Tower and Load Carrier

framing. Stairs were built with a hand rail, instead of merely using ladders. Where operations were carried on overhead, protective cover was provided. Loose boards were piled instead of lying around. No boards with projecting nails were scattered around. Cofferdam walls were stout and true to shape. Wire rope was well kept and new rope was on hand when needed. The job was fenced off and a gate provided for access. No ropes, hoses, or loose wire lines were lying around.

Following is the summary of the principal estimated quantities and bid prices of the original contract:

Item	Unit	Est. Quan.	Unit Price	Amount
Clearing	Acre	12.1	$110.00	$ 1,331.00
Grubbing	Acre	4.8	110.00	528.00
Excavation, Class "A," including 600 ft. haul	Cu. Yd.	83,880	0.18	15,098.40
Excavation, solid rock, including 600 ft. haul	Cu. Yd.	16,250	0.65	10,562.50
Excavation, structure, including 600 ft. haul	Cu. Yd.	700	1.00	700.00
Excavation, Class "D," including 600 ft. haul	Cu. Yd.	220	1.00	220.00
Overhaul on above materials	Sta.-Yd.	1,430	0.03	42.90
Overhaul on above materials	Mi.-Yd.	25,300	0.15	3,795.00
Slope treatment	Lin. Ft.	5,460	0.10	546.00
Excavation, structure	Cu. Yd.	3,330	4.00	13,320.00
Concrete, Class "A," in place	Cu. Yd.	1,160	20.00	23,200.00
Concrete, Class "B," in place	Cu. Yd.	930	14.00	13,020.00
Concrete, Class "D," in place	Cu. Yd.	445	9.50	4,227.50
Furnishing and driving timber test piles	Only	4	50.00	200.00
Furnishing timber piling, untreated, at site	Lin. Ft.	12,880	0.16	2,060.80
Driving timber foundation piles, in place	Only	322	6.00	1,932.00
Steel reinf. bars, in place	Lb.	353,000	0.04	14,120.00
Structural carbon steel, in place	Lb.	499,000	0.07	34,930.00

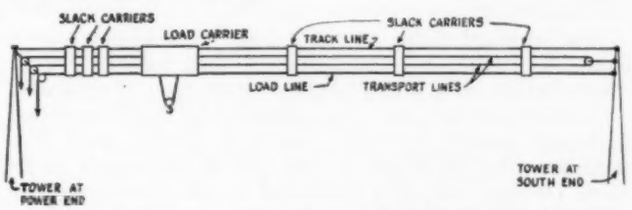


Fig. 15.—Schematic Sketch Showing How Slack Carriers Space Automatically When Load Carrier Is Pulled Over to One End of Track Line

Fig. 16.—Driving Timber Piles on Bent 5 on MacRae's Job. Note Extension of Top of Leads for Handling Jetting Equipment

Structural silicon steel, in place	Lb.	370,000	0.07	25,900.00
Cast Steel, in place	Lb.	8,150	0.15	1,222.50
Reinf. conc. br. railing, in place	Lin. Ft.	446	2.70	1,204.20

SUPPLEMENTAL CONTRACT

Excavation, structure, including all haul	Cu. Yd.	2,500	$ 6.50
Concrete, Class "A," in place	Cu. Yd.	1,465	22.50
Concrete, Class "B," in place	Cu. Yd.	220	20.00
Concrete, Class "D," in place	Cu. Yd.	360	11.00
Steel reinf. bars, in place	Lb.	454,000	0.05
Cast steel drains complete, in place	Only	6	25.00 ea.
Reinf. conc. bridge railing, in place	Lin. Ft.	774	4.00
Furnishing steel foundation piling, at site	Lin. Ft.	7,600	2.25
Driving and capping steel piles, in place	Only	76	45.00 ea.
Structural steel, in place	Lb.	4,100	0.08
Reflector unit complete, in place	Only	1	6.00
Excavation, Class "D," incl. all haul	Cu. Yd.	8,000	0.35
Splicing steel piles	Only	76	10.00 ea.

One hundred eighty calendar days were allowed from June 28, 1940, for completion of this 5-span, 387-ft. trestle bridge with a cantilevered short span at each end.

Concrete bridge floors are finished by hand operated strike off boards. Finishing machines are not used. The state provides drawings of the two strike boards to be used. Designs are also furnished so the contractor can make his check template wooden float, wooden 10 ft. straight edge, and wooden transverse float.

General Contract

EAST FORK LEWIS RIVER TO NORTH OF WOODLAND

The work being accomplished on this section of the project consists of clearing and grubbing, draining, grading, placing of riprap and changing of the channel of the Lewis River. The contract, signed Nov. 25, 1939, allows 300 calendar days for completion of the 2¼ miles. Part of the grading was scraper work but the most of it is a hydraulic fill. Material from the channel change is pumped in to make the fill across the valley floor. This section extends from a point 0.6 mi. north of the crossing of the East Fork of the Lewis River to a point approximately ¾ mi. north of the Town of Woodland. Three short sections where cuts had to be made were constructed prior to hydraulic operations. Both the cuts and the fills were built to a grade 1 ft. below profile grade. This was done so that the substructure of earth immediately below the subgrade would be uniform. Frank Pennepacker is sub-contracting the cut and fill work from General. At this writing he is working about half a mile south of the Lewis River bridge. This bridge, incidentally, is within the limits of General's contract but is set up as a separate construction contract.

The soil in which Pennepacker is working is a silty sand with pockets of saturated silt in places in which the tractors bog down and have to be pushed out. The cut will be about 35 ft. deep when complete and the fill about 40 ft. high. The haul is about 1,000 ft. and takes about 13 minutes for a round trip. The big fill on which the outfit is now working is 320 ft. wide at the bottom and is being spread in about 4 in. layers. The hauling equipment is considered to give satisfactory compaction with the existing natural water content, so no rolling equipment is employed.

Pennepacker is using the following equipment on soil work:

1—Caterpillar RD8 hauling 12-yd. and 9-yd. Le Tourneau scrapers in tandem.
1—Caterpillar D8 hauling 12-yd. and 9-yd. Le Tourneau scrapers in tandem.
1—Caterpillar RD8 hauling a 12-yd. Le Tourneau scraper.
1—Caterpillar RD8 hauling a 9-yd. Le Tourneau scraper.
1—Caterpillar RD8 with Le Tourneau bulldozer.
1—Homemade ripper.
1—Caterpillar 12 ft. motor grader.
1—Northwest ¾-yd. drag line for laying culvert pipe.
1—Caterpillar 75 for culvert work.
1—P&H Smootharc electric welder.
1—Semi-trailer fuel tank.

There is one cut of about 17,000 cu. yd. of solid rock yet to be tackled. This will be drilled by a couple of air compressors, shot with dynamite, and hauled by the scrapers.

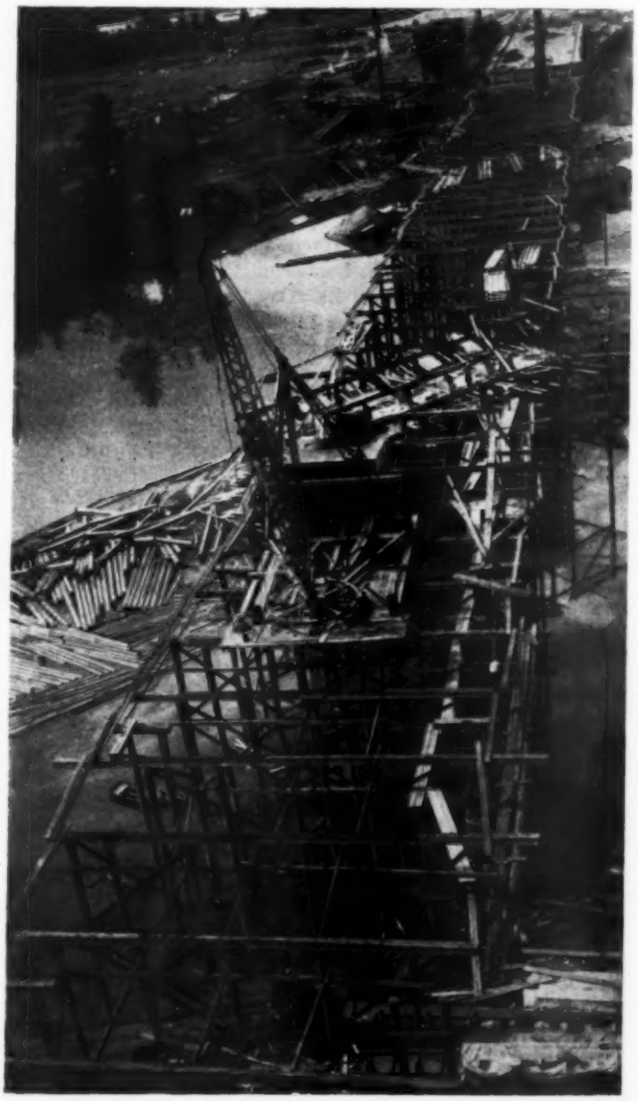


Fig. 17.—Showing Construction Falsework of MacRae's Job. Concrete Plant in Background. Note Dangerous Loose Plank Walkway for Use of Construction Labor. Stiff Leg Derrick In Foreground Now Used for Setting Steel. This Picture Was Taken from the Top of the South "High Line" Tower

General is doing the hydraulic grading and the placing of the riprap on the channel change slopes and roadfill slopes. They sub-let the hauling of riprap which was carried about 8 mi. in 3-yd. trucks. The riprap is placed loose by a power crane. The trucks dump their loads onto a skip, made by the contractor, about 7 ft. by 8 ft. in size with about 3 ft. walls on 3 sides. The skip is so built that two of the chains which hook onto the four corners,

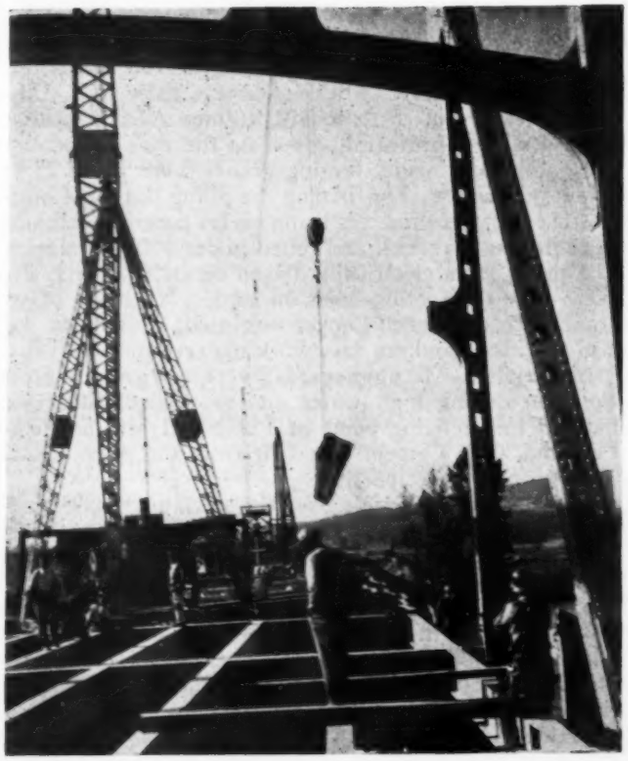


Fig. 18.—"High Line" Bringing in a Column. Pete MacRae, with Straw Hat, Turned Around Just as Camera Snapped. Stiff Leg Derrick Will Pick Up Column and Place for Iron Workers to Bolt in Position

will automatically unhook when the skipload is lowered to place. The crane operator is an artist at handling the skip in spreading the rock. It has the appearance of hand placed rock.

Hydraulic Grading.—The material for the embankment on the north end of the project is a coarse sand that comes from a channel change.

A 15 in. hydraulic dredge pumps it to make the roadbed fill. About 7,000 ft. of 15 in. pipe are available for use, but the longest stretch of pumping will be about ¾ mi. For this section a booster centrifugal pump is inserted in the line to force the material ahead.

For holding the hydraulic material in the deep fill sections, dikes are built of the natural ground in about 12 ft. lifts. It will require 3 lifts to bring the fill up to grade. A section is diked off and an outlet sluice box installed in the dike at the opposite end from which pumping starts. Outlet pipe conduct the waste water back to the river from the sluice boxes. A bulldozer and dragline are used to build the dikes. The pipe runs down the top of a dike.

Fig. 19.—Telephone Control from Erection Site to "High Line" Operator

The dredge works 24 hours a day, unless shut down for some repair, and produces about 200 cu. yds. of filll an hour when working.

An interesting feature of this part of the job is the provisions made for keeping water circulating in the loop section of the river cut off by the new road. It so happens that the outlet sewer for the town of Woodland empties into the loop section cut off. So the water must not be allowed to become stagnant. At the upstream end of the loop, a 24 in. concrete pipe with a sluice gate near the inlet end was placed across the road at a grade to be below low water of the river. At the downstream end a 36 in. concrete pipe under the road permits the water to pass from the loop back into the changed river channel. A tide gate is fastened on the lower end to prevent high water from backing into the loop.

Following is a list of equipment in use by General:

1—15-in. hydraulic dredge.
7,000 ft. 15-in. dredge pipe.
1—Pipe tightening hand winch.
1—Cletrac 80 with bulldozer.
1—Austin-Western 12-ft. hydraulic pull grader.
1—Northwest 2½-yd. dragline.

Fig. 20.—Pouring and Finishing Deck of Approach Structure Which is 48 ft. Curb to Curb. Transverse Screed in Foreground. Workmen Operating Longitudinal Screed in Back. Because of Extreme Roadway Width, Elevated Screed Guide Had To Be Built Into Framework

Following is a summary of the principal estimated quantities and bid prices:

Item	Unit	Est. Quan.	Unit Price	Amount
Clearing	Acre	25.71	$160.00	$ 4,113.60
Grubbing	Acre	7.25	160.00	1,160.00
Excavation, unclassified, incl. 600 ft. haul	Cu. Yd.	132.200	0.24	31,732.80
Excavation, structure, incl. 600 ft. haul	Cu. Yd.	1,510	2.00	3,020.00
Excavation, Class "D," incl. 600 ft. haul	Cu. Yd.	220	1.00	220.00
Overhaul on above material	Sta.-Yd.	51,160	0.02	1,023.20
Overhaul on above material	Mi.-Yd.	16,000	0.13	2,080.00
Hydraulic embankment, in place on roadway	Cu. Yd.	1,035,000	0.211	218,385.00
Hydraulic embankment, in place in waste areas	Cu. Yd.	274,470	0.211	57,913.17
Slope treatment	Lin. Ft.	2,910	0.10	291.00
Special loose riprap, in place	Cu. Yd.	20,120	2.60	52,312.00
Hand placed riprap, in place	Cu. Yd.	20	5.00	100.00

Fig. 21.—Closer View of Raised Screed-Guide. Guide and Bolts Are Removed After Finishing is Completed. Holes Are Filled With Concrete

MacRae Contract

LEWIS RIVER BRIDGE AND APPROACHES

This job consists of the construction of a through high truss bridge continuous over two supports. It is flanked by modified reinforced concrete T-beam deck structure approaches supported on reinforced concrete trestle bents, The footings of all piers and trestle bents are supported by piling. A peculiar feature of this 810 ft. continuous steel structure is the fact that while the end piers are square with the roadway, the two center piers are skewed at 43° 22′. There are thirty 27-ft. panels, c-c of end bearings. The total length of the bridge, including approach structures is 1,309 ft. 8 in. The north approach is 249 ft. 3 in. long and the south approach, the same. The overall length of the steel structure is 811 ft. 2 in. The skew on the center piers is such that, at one end of the truss, the support on the first pier on one side is two panel lengths farther than on the other side of the truss.

Excavation for the footings was started at the north end. Falsework for the truss and deck erection of the approach spans was started about the same time. For the river piers Carnegie steel sheet piling was driven for cofferdam construction. Excavation was removed to footing grade by a 15-ton Whirley stiffleg derrick and a 1¼-yd. clamshell bucket, working on the falsework. Piles were driven from 70 ft. to 110 ft. long. At this location the bed rock is uniformly level. At the time foundation excavation was made, footing grades were about 25 ft. below water level. For driving the piling the same outfit was used that Hoffman is using on his contract. All piles were driven to refusal and jetted under 150 lb. pressure. The pump is an electrically driven centrifugal unit. For excavating the footing holes on land, a Koehring ¾-yd. crane with clam shell bucket was used. This outfit was also used for handling falsework materials.

Fig. 22.—E. J. Nettleton (Left) and Peter MacRae

Materials.—All aggregates were barged in from Portland during high water and stockpiled. Steel was trucked in from the plant of Poole and McGonigle of Portland, Ore. Cement was sent from the plant by rail and trucked to the job site.

For handling materials from the stock pile to the mixer charging bins a guy derrick was set up. This derrick also handled the steel from the trucks and to the "high line." The mixing plant was built out of wood around a 27-S Smith mixer. Concrete was transported from the mixer to the forms or in place by a Heltzel concrete bucket on which the sides had been extended about 15 in. The "high line" carried the bucket from the mixing plant to the point where it was to be deposited.

"High Line."—At the north end of the bridge structure and just west of it a 140-ft. fabricated steel mast was guyed in place. At the south end of the bridge about midway of the length of the approach span and just to the east of the approach a 150-ft. fabricated steel tower was guyed. Between these towers a "high line" or slack line cableway operated to handle most of the construction loads. The towers are 1,100 ft. apart. The whole outfit was designed by the contractor.

On the main cable track a load carrier operates. On each side of the load carrier are three slack carriers. The purpose of the slack carriers is to keep track line, power line and load line separated at all times. They are designed to travel along the track line at different rates of speed so that when the load carrier is in the center of the span and the six slack carriers are evenly spaced, three on each side of the load carrier, they will fit closely together when the load carrier is at one end or the other of the track line. Accompanying sketches show how the load carrier is hooked up with the various lines and how the slack carriers are designed.

The "high line" picks the fabricated steel from where the guy derrick placed it and transports it to position on the falsework. For control of this operation a telephone system is in operation between the erection crew and the "high line" engine operator.

At the site of erection of the steel, a 15-ton stiff leg derrick operating on the falsework, takes the steel from where the "high line" deposited it and sets it in place for the iron workers to bolt up. Here another artist is at work. He is one of the "iron monkeys." For picking up or lowering the load, instead of using the customary hand signals he makes a noise with his throat that sounds like a donkey engine whistle. This little stunt greatly speeds up erection work.

Following is a summary of the principal estimated quantities and bid prices:

Item	Unit	Est. Quan.	Unit Price	Amount
Excavation, structure	Cu. Yd.	10,000	$ 4.60	$ 46,000.00
Concrete, Class "A," in place	Cu. Yd.	2,370	19.50	46,215.00

Concrete, Class "B." in place	Cu. Yd.	3,000	19.50	58,500.00
Concrete, Class "D." in place	Cu. Yd.	1,420	19.50	27,690.00
Steel rein. bars, in place	Lb.	890,000	0.047	41,830.00
Structural carbon steel, in place	lb.	2,100,000	0.0775	162,750.00
Structural silicon steel, in place	Lb.	810,000	0.0825	66,825.00
Cast steel, in place	Lb.	48,000	0.14	6,720.00
Furnishing untreated timber piling, at site	Lin. Ft.	72,000	0.185	13,320.00
Driving foundation piles, in place	Only	1,266	10.00 ea.	12,660.00
Reinf. conc. hand railing, in place	Lin. Ft.	788	3.50	2,758.00

Personnel

The project was designed by the Department of Highways, State of Washington. Lacey V. Murrow is Director of Highways, and E. C. Simpson is District Engineer with general supervision. Contract 2629 is being done by the Kuckenberg Construction Company, 11104 N. E. Holman St., Portland, Ore. Linn Hill, Superintendent, cooperates with H. L. Kline, Resident Engineer, to complete the job. Contract 2472 is the Harold Blake Estate contract. Their address is 400 No. Thompson St., Portland, Ore. Supt. Ed Brown completed this job last fall. Contract 2473 is under construction by L. H. Hoffman, 715 S. W. Columbia St., Portland, Oregon. Supt. J. A. Wall and Resident Engineer R. C. Mills are busy on the contract extension work. Contract 2567 will be completed some time in November by the General Construction Company, 3840 Iowa St., Seattle, Wash. L. S. Gardner is Superintendent for the contractor who subbed part of the work to Frank Pennepacker. Pennepacker's superintendent is Kenneth Cater. Resident Engineer Harry Kline has field supervision of this contract. Contract 2559 is in progress by MacRae Brothers, 614 Fifth Ave., Seattle, Wash. Pete MacRae is on the job most of the time. Albert Skinner is superintendent of steel erection and Ed Ausness has charge of concrete work. For the state E. G. Nettleton is Resident Engineer.

Asphalt Conference to Be Held at Dallas, Tex.—With the cooperation of the United States Public Roads Administration, the State Highway Department of Texas, the Highway Research Board of the National Research Council and the Association of Asphalt Paving Technologists, The Asphalt Institute will hold the 13th National Asphalt Conference at Dallas, Tex., during the week of Dec. 9th, 1940. The Conference will stress the subject of National Defense from a highway and airport angle. Col. Patrick J. Hurley, ex-Secretary of War, will deliver the keynote address on National Defense. It is expected that some 2,000 engineers, technologists, contractors and representatives of the Petroleum Industry will be in attendance.

Bridge Design Competition—The American Institute of Steel Contruction has announced another annual bridge design competition. It is open to bona fide registered students of structural engineering and architecture in recognized technical schools of the United States and its possessions, and offers three cash prizes of $200, $100 and $50 respectively, for the designs placed first, second and third. The subject of the competitive design is a steel overpass bridge to carry a single track railroad over a highway. Further particulars can be obtained by addressing the American Institute of Steel Construction, 101 Park Ave., New York, N. Y.

CONCRETE INDUSTRIES EXPOSITION TO BE HELD IN CHICAGO

The 1941 Concrete Industries Exposition will be held Feb. 10, 11 and 12 at the Sherman Hotel, Chicago, Ill. The exposition again will be held concurrently with the annual conventions of the National Concrete Masonry Association, the American Concrete Contractors Association, the National Cinder Concrete Products Association, the Cast Stone Institute and the American Concrete Pipe Association.

E. J. Goes of the Koehring Co. has been named as chairman of the Manufacturers' Publicity Committee, which has been formed to promote attendance. Also named to this committee are: G. H. Pfeifer, Chain Belt Co.; A. J. Gerlach, Paulson-Gerlach & Associates; G. A. Loveall, Construction Machinery Co.; L. L. Jacobs, The Buchen Co.; J. J. Buzzell, Besser Manufacturing Co.; R. Marshall, Stearns Manufacturing Co.; T. J. Harris, J. R. Hamilton Advertising Agency; Roy N. McCandless, National Concrete Masonry Association; Bert Carey, American Concrete Contractors Association; and Louis Brookman, Jr., Concrete Industries Exposition.

90 TON LOAD ON 50-TON TRAILER

Mr. Art Brockman, contractors equipment mover of Detroit, Mich., was recently confronted with the task of moving an 87½ ton press head for a big automobile manufacturer.

Trailer Carrying 90-Ton Load

His largest trailer was a Rogers Model D-50-D 50 ton drop-deck job. A reinforcement of the main trailer beams at the expert recommendation of Rogers Bros. enabled Mr. Brockman to satisfactorily load and haul a combined weight of over 90 tons on the trailer.

Graduates of 48 Colleges on Indiana Engineering Staff—Among the engineering personnel of the State Highway Commission of Indiana are graduates of 48 different colleges and universities with a combined total of over 1,000 years of technical engineering training. Among 25 division heads and their chief assistants there is a combined experience of 325 years with the State Highway Commission, an average of 13 years each. Numbered among the engineering personnel are 123 who have served from eight to 21 years with the Commission, with an average of 12.7 years service by the entire group.

Non Dust Adhering Lubricant for Surveying Instruments—A lubricant to which dust does not adhere has been found useful in eliminating 'sticking' of clamps, tangent and leveling screws of transmits and levels, for surveying work. The lubricant consists of Acheson colloidal graphite suspended in carbon tetrachloride. When applied, the carbon tetra-chloride evaporates, leaving a fine film of graphite serving as a 'dry' lubricant. Information on this lubricant is available from Acheson Colloids Corporation, Port Huron, Mich.

SOIL NUMBER DEVELOPED TO AID ENGINEERING JUDGEMENT

Test Arbitrarily Weighted To Indicate Relative Values

By KEITH BOYD

Materials Engineer,
North Dakota State Highway Department

IN 1937 North Dakota began making simple soil tests as a preliminary step towards the complete analysis of the material to be used on its grading projects. That fall two soil surveys were made, but little use was made of the information secured.

In the spring of 1938, soils work was started on a permanent basis with a trained soils engineer in charge of the field work and the laboratory organized to make a complete analysis of all samples received. The procedure followed closely the methods recommended by the A.A.S.H.O. A continuous profile was prepared from the regular profile made by the preliminary survey party, upon which was shown the existing ground line, the proposed grade and ditch lines of the road to be built, and the topography. Borings were taken as required to establish the various soil horizons, samples secured, sent to the laboratory, and classified in accordance with the Public Roads grouping A1 to A8. These soil horizons were then shown on the profile.

The completed soil profile was studied and recommendations made for subcutting, correction of frost boils, and soil selection to place better material in the upper portions of the fill. The profile was then re-drawn and included as a regular part of the plans issued for a project, to be used by the contractor and the engineer in charge of the work.

We knew and frankly stated that full use was not being made of the information thus obtained. We felt that it was desirable to make a very mild start, slowly acquainting everyone connected with grading work with the soil profile and its use, without either suddenly increasing costs or creating active opposition to its adoption.

After a year, it became apparent that more use should be made of the work to justify the expense. Studies made, of the soil profiles completed, revealed many soil types on any project. Obviously their capacity to support traffic loads were not the same and therefore the amount of base

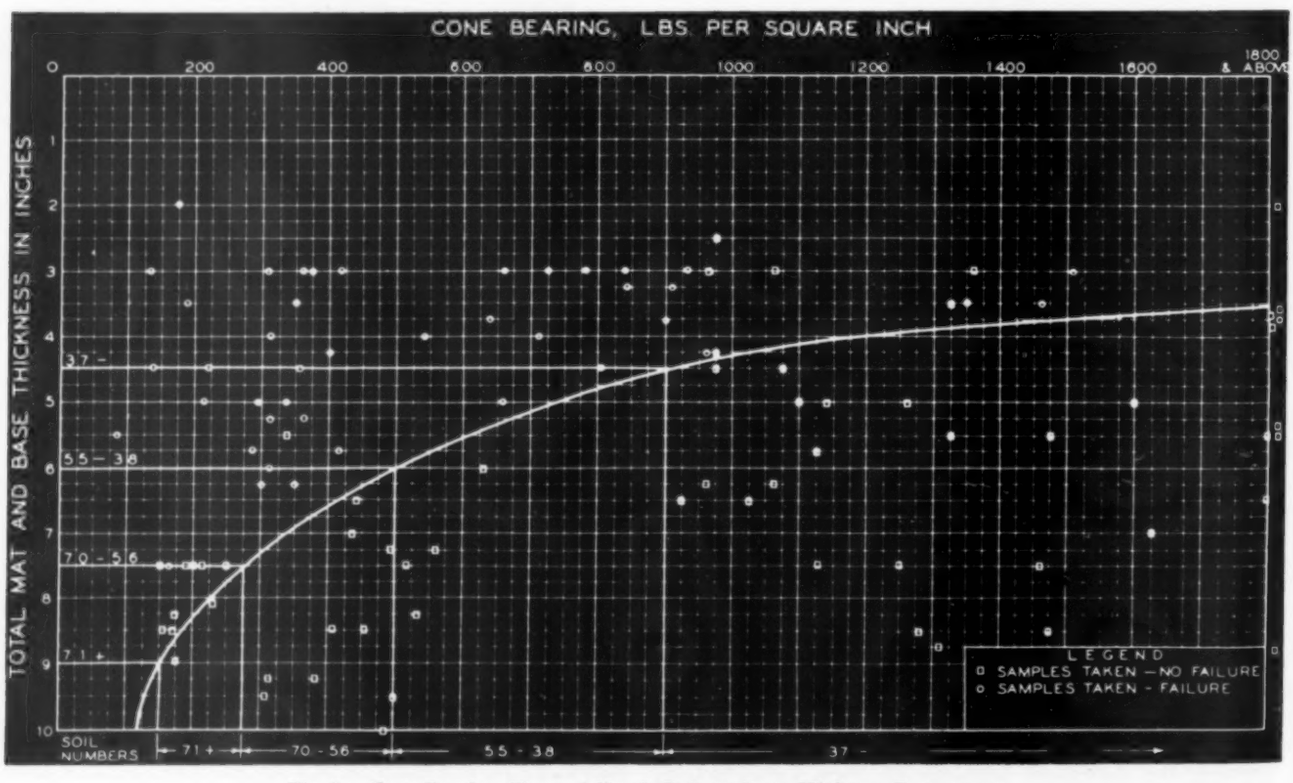


Fig. 1.—Cone Bearing Chart of North Dakota State Highway Department

Density Determination, Using Oil, of Soil in Its Undisturbed Position. Horizons Are Noted and Samples Secured for Laboratory Analysis from the Same Pits

and mat that would be necessary to support these loads uniformly need not be the same. However, we were unable to find a completely workable method for classifying soils and predicting in advance its bearing power which in turn could be expressed in terms of adequate base and mat thickness.

It was finally decided that original research was necessary to develop exactly the data needed for our own state. North Dakota has many miles of bituminous surfaced highways. Some sections with little base and mat remain in good condition for years; other sections with thicker bases and mats show occasional signs of weakness. We knew that heavy gumbo clays needed much thicker bases than sandy loams. In order to crystalize this knowledge into definite terms, we made a survey of typical sections of surfaced roads throughout the state.

This survey consisted of measuring the mat and base thickness, the moisture content, density, bearing capacity of the subgrade soil, and a sample taken for laboratory analysis. The condition of the surface was noted and any other conditions of possible interest recorded.

Determining Base and Mat Thicknesses

The bearing power of the soil was determined by means of a cone device of our own design. The cone was loaded successively with 10, 20, 40, and 80 lb. weights and the amount the cone penetrated into the subgrade was measured and recorded for each increment of load. Bearing power was expressed in pounds per square inch based on the cross sectional area of the cone at the ground line. The calibrations and corrections necessary to give consistent results for each load is a separate problem and will not be discussed here. It suffices here to say that the bearing power shown for each increment of load gave very consistent results, that the average was taken and shown as the true bearing power of the soil as found in the subgrade, at that particular moisture content.

Plotting the bearing power (see Fig. 1), in pounds per square inch of the subgrade soil against the total thickness of base, plus mat thickness, and indicating with a suitable symbol those samples that failed or were in good condition, showed that the failures were grouped on one side of the graph and the good samples on the other. These groups could be definitely divided by a curved line. This line represents the minimum base and mat thickness needed to support traffic with any given bearing power. Additional tests are being taken that will definitely establish the boundary between sufficient and insufficient bases.

This chart therefore shows that any given bearing has a corresponding base and mat thickness necessary for adequate support. While this information is interesting, it is of little value unless the soil can be identified and its bearing power predicted in advance.

Soil Numbers Developed

The samples secured from the subgrade and tested in the laboratory were studied. They revealed that samples with bearings as low as 150 to 200 lb. per square inch were A7 clays; that samples with high bearing (disregarding those that had low moisture content, any dry soil has a very high bearing) consisted of well graded gravels and sands.

It was impossible to use the Public Roads classification in relation to bearing, as some A2 soils had less bearing than A6 or A4 soils and no definite bearing limits could be established. We conceived the idea that if soil of the best type A1 could be assigned a small number (derived by formula) and poorer soils an increasingly higher number, then we would be making definite progress.

The soil value formula, Table I, has been developed to give a low number to any individual test as it approaches the base figure which is considered good. Thus a liquid limit of 20 is better than a liquid limit of 60. A base number, 15, was chosen for the L.L. so that practically all samples could be subtracted. The liquid limit of 20 is 5 more than 15, and divided by 5 as given in the formula, equals one. A liquid limit of 60 is 45 more than 15, which divided by 5, equals 9 and indicates the relative qualities of the two samples.

This principal was repeated for all the items shown in the formula and the numbers totaled. A sample which corresponds closely to all the base numbers has a low total number, say 25, and one that varies a great deal will have a total of say 75, and must be very much inferior to

TABLE I.—SOIL VALUE FORMULA

Passing No. 10 Sieve	(Sample — 60) ÷ 5	If percentage passing is less than 60, reverse order and subtract result from total.
Coarse Sand	(60 — Sample) ÷ 10	If percentage of coarse sand exceeds 60, reverse order and add number in regular manner. Thus sample may be penalized by too much coarse sand.
Fine Sand	(50 — Sample) ÷ 5	Use same method as for coarse sand if percentage exceeds fifty.
Silt	(Sample — 10) ÷ 5	If silt is less than 10, reverse as above.
Clay	(Sample — 10) ÷ 5	Same as for silt.
L.L.	(Sample — 15) ÷ 5	Same as above.
P.I.	(Sample — 5) ÷ 5	Same as above.
Field Moist Equiv.	(Sample — 10) ÷ 10	Less than 10, soil value number is zero.
Centr. Moist.	(Sample — 10) ÷ 10	Less than 10, soil value number is zero.
Shrinkage Limit	(Sample — 20) ÷ 5	If S.L. is less than 20, reverse order and add number in regular manner.
Shrinkage Ratio	(2.0 — Sample) ÷ .05	Shrinkage ratio above 2.0, soil value number is zero.
Volume Change	(Sample) ÷ 10	
Specific Gravity	(2.80 — Sample) ÷ .05	Specific gravity above 2.80, soil value number is zero.
Dry Loose Weight	(100 — Sample) ÷ 10	Weight above 100, soil value number is zero.

Express soil numbers in whole figures, never as fractions or decimals.

For A3 soils, add 10 to total in lieu of values for F.M.E., Centrifuge Mois., Shrinkage Limit, Shrinkage Ratio, Volume Change, and Specific Gravity

TABLE II.—TYPICAL ANALYSIS OF STABILIZED GRAVEL BASE AGGREGATE AND PUBLIC ROADS GROUPING A1 TO A8 WITH SOILS VALUES EXPRESSED NUMERICALLY

	No. 1 Stab. Base Aggregates Lab. V.	Form V.	No. 2 Stab. Base Aggregates Lab. V.	Form V.	No. 3 Lab. V.	Form V.	No. 4 Lab. V.	Form V.	No. 5 Lab. V.	Form V.	No. 6 Lab. V.	Form V.	No. 7 Lab. V.	Form V.	No. 8 Lab. V.	Form V.	No. 9 Lab. V.	Form V.	No. 10 Lab. V.	Form V.
% Pass. ¾" Sieve	91.8	....	91.6	.....	100.0	....	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....
% Pass. ¾" Sieve	87.4	....	78.4	.....	99.0	....	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....
% Pass. No. 4 Sieve	70.5	....	63.3	.....	92.0	....	.....	....	100	....	.....	....	.....	....	.....	....	.....	....	.....	....
% Pass. No. 10 Sieve	50.8	—2	45.3	—3	86.0	5	75.6	3	99.9	8	96.3	7	99.3	8	97.3	7	99.9	8	99.9	8
Coarse Sand	19.6	4	16.1	4	50.0	1	31.7	2	3.0	6	5.8	5	3.6	6	5.8	5	0.4	6	2.0	6
Fine Sand	12.5	7	10.3	8	12.0	7	24.8	5	91.7	8	37.0	2	33.8	3	26.9	5	8.4	8	38.8	2
Silt	13.7	1	13.5	1	17.1	1	7.9	0	3.6	1	43.1	7	42.3	6	26.9	3	36.4	5	48.3	8
Clay	5.0	1	5.4	1	6.9	1	11.2	0	1.6	2	10.4	0	19.6	2	37.7	5	54.7	9	10.8	0
Liquid Limit	33.5	4	33.7	4	19.0	1	35.9	4	15–20	0	40.5	5	46.3	6	38.9	5	59.4	9	81.6	13
Plasticity Index	6.7	0	8.2	1	3.0	0	12.8	2	0	1	12.2	1	17.8	3	21.7	3	31.6	5	7.5	1
Field Moist. Equiv.	27.2	2	26.7	2	17.0	1	26.0	2	17.2	1	30.5	2	35.4	3	25.7	2	38.2	3	62.3	5
Centrifuge Moist.	19.0	1	22.5	1	10.0	0	24.7	1	3.0	1	27.5	2	33.0	2	23.2	1	34.9	2	40.8	3
Shrinkage Limit	24.2	1	23.7	1	17.0	1	23.6	1	16.6	1	21.8	0	26.2	1	13.7	1	14.0	1	42.1	4
Shrinkage Ratio	1.632	7	1.628	7	1.8	4	1.67	7	1.82	4	1.66	6	1.49	10	1.95	1	1.81	4	1.07	19
Volume Change	4.9	0	4.8	0	0	0	4.0	0	1.0	0	14.4	1	13.7	1	23.4	2	43.8	4	21.6	2
Specific Gravity	2.60	4	2.55	5	2.60	4	2.74	1	2.63	3	2.57	5	2.45	7	2.66	3	2.44	7	1.95	17
Dry Loose Wt./Cu. Ft.	106#	0	109#	0	.....	....	82	2	88	1	74	2	69	3	80	2	70	3	45	6
BPR Group	A4	....	A4	....	A1	....	A2	....	A3	....	A4	....	A5	....	A6	....	A7	....	A8	....
Soil Number	.....	30	.....	32	.....	26	.....	30	.....	37	.....	45	.....	61	.....	45	.....	74	.....	94

the first. Greater value was given some characteristics than others by dividing by a smaller number to emphasize what we consider the more important qualities of a soil.

Soils Divided into Four Groups

Table II gives the analysis and values for the material composing a standard stabilized gravel base as built in this state, and typical data and values for the Public Roads group A1 through to A8. The fact that stabilized gravel base material does not necessarily get an A1 group rating on the fraction passing the No. 40 sieve, emphasizes the value of considering the coarser fractions and warns against placing too much stress on the A1 to A8 series.

Using this method, we have divided our soils into four groups:

Soils number 37 and less comprise the best material and include all of the A1, nearly all the A2 and A3 groups, and occasionally an exceptionally good A6. Soils numbered from 38 to 55 include the majority of our soil. Good A6-A4 material is found within this range and occasionally poor A2 and sometimes a one-grain size A3 before treatment. The third group, 56 to 70, contains the biggest portion of the bad soils, A4 of the frost boil type. A5's spongy weak and entirely unfit for base support. some A6 and A7's of the better type. The fourth group. 70+, contains mostly A7 and A8 groups.

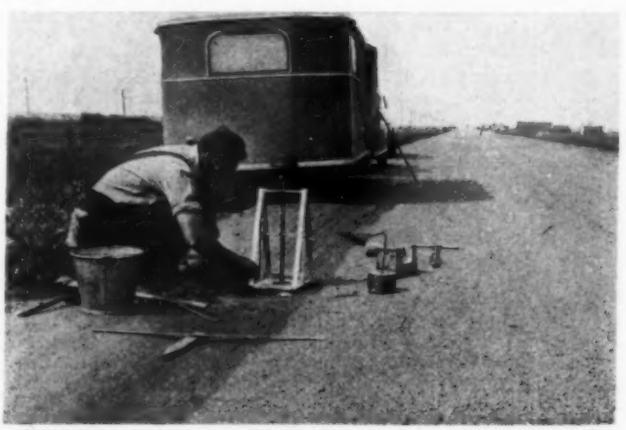
Results of the study show that the A5 group is entirely unsuited for subgrade use and should be either wasted or buried in the fill. A soil value number exceeding eight for shrinkage ratio signals danger. A soil value number exceeding 7 for silt content means dangerous A4 soils providing water is available for frost action. Such material should be kept out of sloughs and low country with high ground water or where ditches are not available for drainage, such as at underpass sites or city sections. A8 soils (muck) are even more undesirable than A5 soils and should be eliminated from the fill material entirely and wasted.

Soil Numbers Compared with Bearing Power

Ordinarily the standard soil tests are not run on sand samples. For this discussion, tests were made on two samples which were available in our Laboratory and approximate values derived and shown in Table II. To the soil values found by other analysis will be added ten points for the field moisture equivalent, centrifuge moisture, shrinkage limit, shrinkage ratio, volume change, and specific gravity. Addition of some clay should in all cases bring this soil well below the 37 number set for the upper limit of Group 1.

Comparing soil numbers with bearing power, we find that the lowest numbers have the highest bearing and that progressively the higher the soil number the lower the bearing. By this we do not mean that every sample followed this rule. That happens only in books. There are other factors, of which we are perfectly aware, that enter the picture—moisture content, density of soil, age of surface, amount and type of traffic—all have their effect.

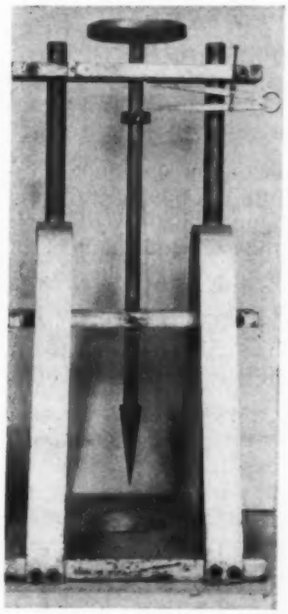
The average bearing for the 37- group is 1,300 lb. and the lowest sample 900 lb. On the chart, therefore, we indicate that soils in this range should have 4½ in. of base and mat. For the groups 38-55, the average bearing



Investigating a Typical Failure. The Mat Has a Depression About 2 Feet in from the Mat Edge. North Dakota Has Two Fully Equipped Trailer Laboratories. One Is Used by the Soil Survey Party, the Other Is Used for Research Work and in Checking Field Construction Laboratories

TABLE III.

Soil Value Number	Public Roads Groups	Total Base & Mat Inches	Type	Remarks
.....	A1, A2	.....	4 in. Base, ½ in. Surface Treatment	Unstable A3 to be consolidated with Clay.
37–	A3	4½	3 in. Base, 1½ in. Bit. Mat.	
.....	A2, A4	.....	5½ in. Base, ½ in. Surface Treatment	Silt values higher than 7, shrinkage ratio values above 8 should be watched and properly placed in embankments.
38–55	A6	6	4½ in. Base, 1½ Bit. Mat.	Do not use where drainage is poor.
.....	A4, A5	.....	7 in. Base, ½ in. Surface Treatment	A4, A5 in this group objectionable. Watch carefully either waste or keep down in grade.
56–70	A6, A7	7½	5½ in. Base, 2 in. Bit. Mat.	
71+	A5, A7, A8	9	7 in. Base, 2 in. Bit. Mat.	Waste A5, A8 soils, if possible, or keep well down in grade.



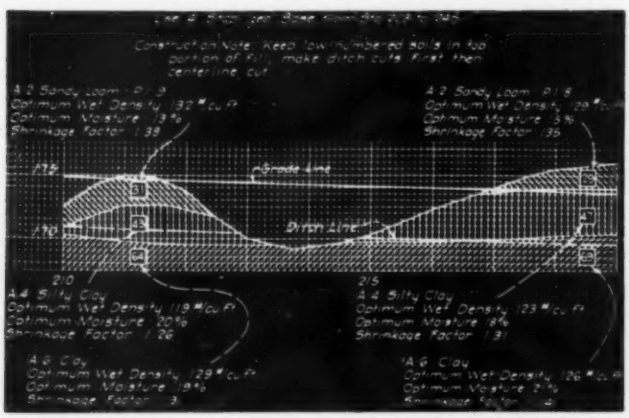
Cone Bearing Device Used to Determine the Load Carrying Capacity of Soil

is 1,075 lb., the lowest bearing recorded is 377. Only two samples are as low as 500 lb. and it has been selected as the lower limit and requires 6 in. of base and mat. Group 56-70 has an average bearing of 550 lb. One sample dropped to 200 and another to 250 lb. However, 275 lb. has been selected as the lower limit and requires 7½ in. of total thickness. The 71+ group has an average of 280 lb. with a low of 150 which requires up to 9 in.

Table III shows the schedule recommended for use.

At the present time we are primarily interested in the principles developed rather than the accuracy of the conclusions so far obtained. We believe that this method will allow more accurate design with a consequent saving in costs. More research may cause us to change the basis for the soil either by eliminating some of the tests in the formula, which admittedly is rather long, or by emphasizing some tests more than we now do. The base thickness to be assigned the various soils group may also be increased with more experience. The principles developed from the work done to date has convinced us of their value and justifies continuance of the studies.

We also feel that the soil survey can be used advantageously to predetermine the proper embankment compaction density of each soil type encountered. Accurate field densities taken of the undisturbed material in the cuts, enable us to estimate the probable shrinkage and design accordingly.


Construction Note: Keep low numbered soils in top portion of fill, make ditch cuts first then centerline cut
A-2 Sandy Loam
Optimum Moisture 13%
Shrinkage Factor 1.38
A-2 Sandy Loam
Optimum Moisture 9%
Shrinkage Factor 1.35
Grade Line
Base Line
A-4 Silty Clay
Optimum Wet Density 119 #/cu. ft.
Optimum Moisture 20%
Shrinkage Factor 1.26
A-4 Silty Clay
Optimum Wet Density 123 #/cu. ft.
Optimum Moisture 18%
Shrinkage Factor 1.31
A-6 Clay
Optimum Wet Density 129 #/cu. ft.
Optimum Moisture 14%
A-6 Clay
Optimum Wet Density 126 #/cu. ft.
Optimum Moisture 21%

Typical Soil Profile Showing Pertinent Data for Use of Design and Construction Engineers

Predetermining Proper Embankment Compaction

During October and November of 1939, a survey was made by the traveling laboratory of the density of soil in embankments recently built and of the soil in its natural position. The following procedure was used:

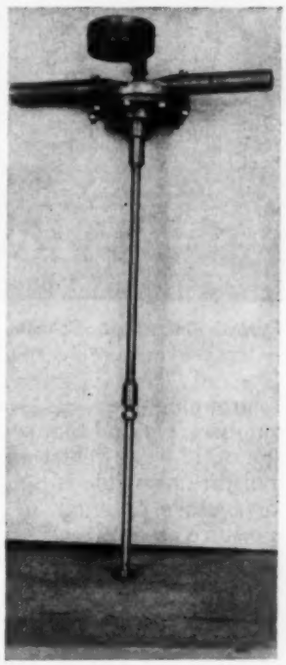
1. A distinctive soil was selected, a soil with a definite color or texture that could be traced and located in the embankment as well as in its natural position.

2. A density test made of the soil in its undisturbed state and the moisture content recorded.

3. A density and moisture test made of the soil as placed in the embankment.

4. A sample taken and submitted to the laboratory.

5. A complete soil analysis made of the soil in the laboratory including the Proctor test for optimum moisture and density.



North Dakota's Proctor Needle Pressure Is Transmitted Through a Rubber Membrane to an Oil Chamber, to which the Gauge Is Attached

This survey when completed and worked up in the office gave us some very interesting information. Some embankment soils had densities as low as 75 per cent of the Proctor optimum while others were as high as 115 per cent. The average of all densities was 98 per cent, secured with ordinary equipment without the adidtion of much water or rigid supervision. The following tabulation shows the per cent of compaction secured, dividing the samples into groups:

	No. of Samples	% of Total Samples
Less than 80% of optimum Proctor density	11	6.2
85%	36	20.2
90%	68	38.2
95%	119	67.0
More than 94%	59	33.0

It is evident that adequate compaction can be easily secured using our present construction methods. If the work is to be uniform, the 68 samples below 90 per cent optimum density must be eliminated. This can be done by competent inspection and the adoption of a simple test procedure.

Sample No.	Sta.	Depth	Elev. in Fill	Opt. Wet Density	90%	Emb. Density	Opt. Moist.	Emb. Moist.	Diff.	% Comp.
1	163+10	5'	4'	135	121.5	124.5	19	21	-2	91%

Field Tests for Emb. Density

Wt. of soil + can 10.4 lbs.
Wt. of Can 1.2
Wt. of soil 9.2

Wt. of oil + can start 16.9
Wt. of oil + can finish 12.8
Wt. of oil used 4.1

4.1 ÷ 55.6 = .0738 Cu. Ft.
9.2 ÷ .0738 = 124.5 lbs. per cu. ft.
Emb. Density

Lab. Tests for Emb. Mois.

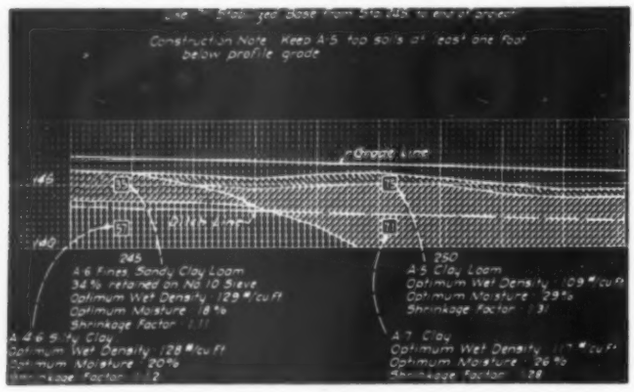
Wt. of soil + can wet 64 grams
Wt. of soil + can dry 55 "
Wt. of Mois. 9 "
Wt. of Can 12 "
Wt. of dry soil 43 "

9 ÷ 43 = 21% Emb. Mois.

124.5 - 2 = 122.5 ÷ 135 = 91% Comp.

These notes to be kept in a Student Field Book.

Fig. 2



Typical Soil Profile Showing Pertinent Data for Use of Design and Construction Engineers

Grouping the soils samples by our method of soils numbers, we find that soils group 37— requires an average of 13.6 per cent water for optimum and the natural moisture available is 8.8 per cent. Soils group 38-55 has an average optimum of 18.0 per cent and the natural moisture is 14.6 per cent. Soils group 56-70 requires 22.4 per cent optimum, and 18.4 per cent natural, the 71+ group 27.6 per cent compared to 23.8 per cent in the natural state. In North Dakota the average soil has within 5 per cent of the correct amount of moisture required for Proctor optimum density.

Optimum density is the density secured with an arbitrarily selected standard for compactive effort. Increasing the amount of effort (more blows with the Proctor hammer for example) secures equivalent densities with lower moisture contents. It is apparent from our tests that contractors have in use equipment capable of producing more compactive effort than our standard compaction and are capable of getting satisfactory results with less water. We believe it logical to specify the density required and let the contractor satisfy this requirement even though

DETERMINATION OF WT. OF OIL PER CU. FT.

Wt. of water + Can 18.7
Wt. of Can 2.1
Wt. of Water 16.6
16.6 ÷ 62.4 = .266 Cu. Ft.

Wt. of Oil + Can 16.9
Wt. of Can 2.1
Wt. of Oil 14.8
14.8 ÷ .266 = 55.6 Lbs. per Cu. Ft.

This test is made to calibrate your oil and need not be repeated so long as you use the same viscosity and brand of oil.

Fig. 3

the soil may be either above or below the optimum moisture. Obviously many soils will not have sufficient water for minimum compaction. A nominal quantity of water equal to about 3 per cent of the soil embankment by weight, or about 250,000 gals. for an average mile, should prove ample for any project.

If the density of the soil in its undisturbed state is known and the density to which it will be compacted in the embankment is controlled, it seems reasonable that

NORTH DAKOTA STATE HIGHWAY DEPARTMENT
MATERIALS DEPARTMENT
SOIL COMPACTION REPORT

Project FAP 1948
County Rolette
Date May 4, 1940
Inspector Read - Osborn

Sample No.	Station of Sample	Elev. *	Opt. Wet Density	90% Wet Density	Wet Density in Emb.	Opt. Mois. %	Moist. in Emb. %	Diff. in %	% Comp.
1	518+25 CL	2	117.0	105.3	104.1	23	16	+7	95
3	517+75 CL	2	117.0	105.3	99.0	23	14	+9	92
7	517+00 CL	4	117.0	105.3	120.9	23	28	-5	99

Instrs.: Take off from optimum density curve, optimum wet density and optimum mois., enter in appropriate columns. Determine emb. wet density and mois. content. Subtract one pound from wet emb. density for each % of mois. above optimum, add 1 lb. for each % under emb. wet density ± Mois. Diff. = per cent compaction.

Opt. Wet Density

* Show height above natural ground line in feet.

Fig. 4

shrinkage factors could be set up for use by the design department and construction forces. A special study is now under way on this problem and we hope to soon be able to eliminate the excessive over and under run in quantities that sometimes occur under the present system. For the coming season we plan only to set up shrinkage factors for the project as a whole based on the results of the soil survey. Eventually we hope to vary the shrinkage factor for short sections as required.

Our soil survey profiles now show the soil horizons identified by the Public Roads classification, the soils number, the Proctor optimum wet density, and the theoretical shrinkage factor. The proper base and mat thickness for each section and the recommended shrinkage factors to use are listed.

How Soil Density Is Checked

The procedure to be used by the construction engineer in the field for checking the density of the soil as the road is built is very simple and has worked successfully on projects built this season. Using a standard field note book, the inspector loads it with the optimum density, 90 per cent optimum density (or in accordance with the specification requirements), and the optimum moisture, all taken off of the soils profile as illustrated by Fig. 2.

The field work consists of a determination of the wet soil density, using the oil method and taking a sample to find the percentage of moisture in the undisturbed soil. If the density requirement is satisfied, then the entire lift along and across the fill can be checked by penetration readings with a Proctor needle. Fig. 3 shows the method used to calibrate the oil used in the density test. Records are kept and submitted to the testing laboratory, Fig. 4, listing the percentages of compaction secured and provides proof that the specifications have been met.

Every effort has been made to keep this field procedure simple and yet reasonably accurate. For example, Fig. 4 shows the method for correcting either an excess or deficiency of water. This is not of course mathematically correct, but the error is never more than 1 per cent. Considering the other factors that enter into the work affecting the accuracy, this discrepancy is negligible.

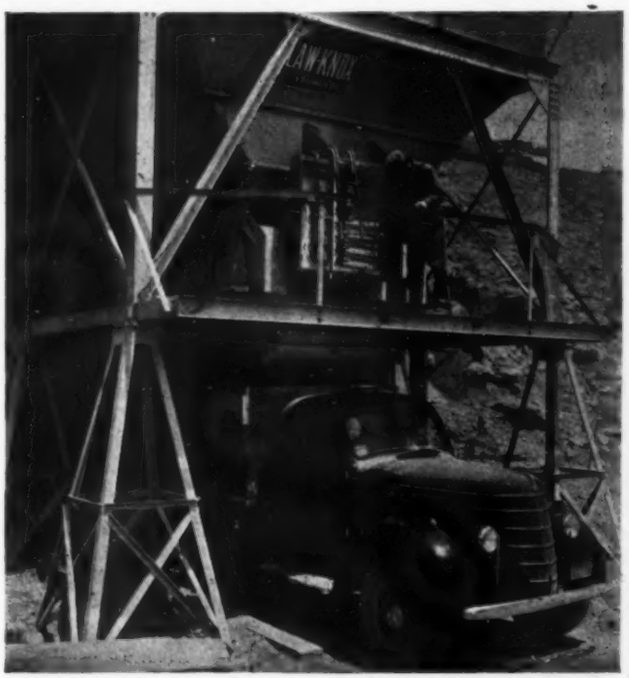
In our opinion, trying to classify and fix the optimum density for every foot of the road to the last pound is foolish and unnecessary. Once the major types are properly compacted and the tests show them to be satisfactory, any unclassified material will be handled in stride and properly compacted. We expect that the cost of a fill inspector making a few simple tests, insuring uniformly good compaction, will pay dividends in the future.

Heavy rains may badly erode a newly constructed grade. This is one of the problems which can be solved in the design stage by full use of these methods and necessary provision made for adequate protection of slopes and ditches.

It is apparent that there are many uses for the soil suvrey. Until the study is much further advanced, full advantage cannot be taken of the work. We believe the work continued as outlined promises rich dividends in the form of better roads at minimum costs.

DOUBLE ACTION BATCHING PLANT

A double action or dual batching plant has been employed by Midwest Construction & Asphalt Co., Chicago, Ill., near Kicksburg, Pa., on its contract on the Pennsylvania Turnpike. The plant, a product of Blaw-Knox Co., has been feeding both a 34-E and a 27-E paver from a single 105-ton aggregate bin, which is equipped with two batchers.



Portable 105-Ton Three Compartment Bin, Equipped with Two 1¼ Yd. Three-Material Weighing Batchers

The bin is of the portable, three-compartment type with a special hopper section to accommodate the two batchers. Each batcher is a 1¼ yd., three material weighing unit equipped with six-beam scales. In the accompanying illustration, only one of the scales can be seen and the other is in the rear.

In the use of these facilities, an effective practice has been developed, resulting in rapid and economical production. Either batcher can be used, of course, for either size batch, and the practice has been to use three beams for one batch schedule and the other three beams for the other size batch. The operator, therefore, does not have to change the poise settings. Moreover, both batchers can and do discharge simultaneously into two-batch trucks without the need for intermediate truck movements.

Once the truck is identified by the operator, it is a simple matter to throw the proper set of beams in or out of engagement with the master beam by means of the trig locks. The identification, too, is simplified because the trucks conveying, for example, the smaller size batch have certain flags on them. This gives the batching operator advance notification of the size batch desired.

If desired at some future time, the special bin hopper section can be replaced with another hopper and single batcher to form a conventional plant.

COUNTY HIGHWAYS AND MILITARY USE

What is believed to be the first recommendation for the preparedness of a county highway system for military use, and especially for emergency airplane landings in conjunction with the system, was made July 23 to the Supervisors of Erie County, New York, by A. J. Yaw, County Superintendent of Highways, Buffalo, N. Y. Mr. Yaw's recommendations follow:

I wish to call your attention at this time to the possibilities of the Erie County Highway System becoming a major factor in the National Defense Program in this section. Taking into consideration this vast manufacturing center with its varied industries which are so vital to the United States Government and its numerous main trunk railways and waterways, the vast amount of electrical energy produced and distributed in this area, there is no doubt that our highways and bridges would be subjected to heretofore unheard of use in case of modern military operations.

We must all concede that modern armies will be equipped with vast numbers of heavy, speedy mechanized units and that the modern airplanes of today are playing the most important part in defense, as well as attack.

Due to the location of the Niagara Frontier and the topography of Erie County, I believe that emergency landing facilities could be advantageously provided in conjunction with and at several strategic points on our highway system.

This would, of course, require additional widths of right-of-way and the removal of all obstructions such as poles, trees and buildings at these points. It would also require that our county roads connecting these points, and to other places of military importance, be made heavier and wider and bridges and culverts reinforced to meet the demands which would be imposed on them during military operations.

Therefore, we believe that a careful study should be made, and should such a program be considered feasible, it is the desire of this department, first and always, to cooperate and work with your Honorable Board of Supervisors and in confunction with the proper Federal Defense officials in financing, which we must all realize will be very costly. In all cases, it is the desire of this department, and I believe your desire, that this work be done by the Erie County Highway Department.

OBSERVATIONS BY THE WAY

By
A. PUDDLE JUMPER

THE LADIES' ISSUE

¶ B. C.—Did you know that Joe had a glass eye?

A. P. J.—No. How did you know?

B. C.—It came out during the conversation.

• •

¶ The lady had just finished a criticism of the city council for the condition of the unpaved street in front of her home. Said the office boy promptly, "If they'd put their heads together they could make a concrete road."

• •

¶ Said the professor to the pretty young thing caught day dreaming in class, "Decline 'love,' Miss Brown."

Miss Brown: "Decline love, professor? Not me."

• •

¶ Sam Swish says the best way to get the most out of life is to fall in love with a great problem or a beautiful woman.

Says A. P. J.—Take the first or you get both.

• •

¶ Wife: I was a fool when I married you.

Husband: With the way I was infatuated, how was I to know it then?

• •

¶ Little Willie was asked to name two ancient sports. He thought for a moment, then replied: "Anthony and Cleopatra!"

• •

¶ Reflector buttons are installed in marker posts in Nevada. Holes are bored so that buttons fit tightly. They are pounded in with a soft mallet.

¶ BOSSES

Note: The following is written strictly for the edification of budding stenographers, clerks and secretaries. Any similarities to any living bosses are strictly coincidental. And just to make it difficult for everybody, so all the bosses can suspect all their secretaries, this article is strictly ANONYMOUS.

I had not meant to publish my findings in the business world for some time. As a matter of fact, I am still collecting statistics and things. But in these times of stress and strife, when a girl has such hard competition for her job, she needs all the hints she can pick up. She needs all her wits and everything.

So I shall expound the results of my six years' experience for your guidance, and classify a few specimens of the genus Boss.

We shall treat first of the FATHERLY Boss, and the proper management of him to bring about the best stenographic results.

The greatest trouble with the Fatherly type is that his paternal streak has probably gotten the best of him before ever he saw you, and he is married. Sometimes he even has children of his own, as old as you are, my dear! As he tells you this fact, a mellow glow may be discerned in his eye. He is given to head-patting,* and likes sweet, simple girls, with natural charm. He abominates peroxide blondes, or too much makeup (though naturally, like most men, he never recognizes such traits when he sees them). Therefore, if you come under one of these headings, simply do not tell him, and he never will know the difference.

* A head-patting incident is an astute time to hit the old bird up for a raise (in a modest, daughterly fashion, of course. You might mention brave, starving mother, or epileptic baby sister, etc).

He is happiest with a little home body, whose mother never told her All (he will enlighten you, my dear), or a girl who, like the worm in the sad little essay, "Ain't got no mamma and ain't got no papa." He is usually glad to oblige you on the latter deficiency.

Then there is the ABSENT-MINDED Boss. He lives in a haze of statistics, his bald head glittering with intensity above his graphs and charts. He can never find his hat, and you could come to the office in your stepins and he would never notice it. His mind is a labyrinth of names, dates and theorums. However, he expects you to remember his appointments and shoo him off to them; remind him to buy his sox, send his wife and relatives cards and presents on appropriate days, and call to remind him to put out the cat at night. He is startled when any fact comes to light which seems to indicate that you live a life beyond the office doors. Does the desk ever have out-of-town relatives gumming up its efficiency? Remarkable that such things could happen to a stenographer! He turns upon you a look of almost human intelligence for a moment, puzzled speculation in his eyes. Then he lapses into a pleasant daze of study, or he grabs a pencil and scribbles thoughtfully into one of numerous fat, loose leaf notebooks. You could not read his writing, and a few days from now he, himself, cannot; but let that pass.

He is best served by a stenographer with a kindergarten complex; one that can look after him, give him medicine for his indigestion, and furnish him umbrellas to lose on rainy days.

We now proceed to the REFORMING Boss. He knows your past,

present, and if he can worm it out of you, your future. He is determined that the world shall be a better place for his having lived on its wicked face, and his employees must be beings of purity and honesty. He usually wears glasses ("The better to see you with my dear," said the Wolf), and goes about piously oozing optimistic platitudes. His health is notably and nauseatingly perfect, and he tells unwary folk just how he keeps it so. He is a living proof that thoughts have no effect on their object. If they did, he would die almost immediately of the dry rot, and purify the world no more.

He is happiest with a stenographer who wears long hair in a severe knot, and long, dun dresses, and whose soul is inky with a lifelong ability to lie and lie and lie.

In direct contrast to the last-treated boss, is the HOTCHACHA, or FLAMING variety of Boss. He comes yawning to work. Whenever he finds a stenographer alone in a room he pinches her cheek (and other places if not vigorously repulsed), and intimates in a veiledly gay manner that his women outside the office are all crazy about him; that all are sizzling specimens, but that he is a sizzlinger.

The best requisite for the girl working for the Hotchacha type is a dependable left hook.

Now all these classes of bosses vary among themselves as to office procedure, and it is best to select one with a disposition that will not harrow you too violently. For instance, if you get dizzy easily, or are already a blonde, you would not wish to work for a man who, after placing you at a table in the center of the room, dictates while racing about the table, his hands behind him like a skater, and his words popping at you from first here and then there (if not somewhere else entirely!). It distracts your attention; and besides, as he dictates faster and faster, he springs more and more rapidly about the table, until completely fascinated by the question of whether or not he will lap himself, the unfortunate peruser of chicken tracks forgets to make them to peruse!

And if you are an impatient soul, you never should work for a man who calls you for dictation, then looks dreamily out of the window for an hour, waiting for inspiration while you tap your pencil on your notebook and get nervous indigestion from fidgeting. He dictates four words every half-hour, and in the course of dictation usually has you go back and scratch out most of them and insert others, equally vapid. This goes on indefinitely, and is one reason why sanitariums are full of women who scream and claw at the bars.

But in case you are an unflustered sort, you would be equally confused by the boss who rushes in, machine-guns a conglomeration of syllables in your direction, grunts and departs, leaving you to figure it out for yourself.

In fact, after due consideration, I would advise you to give up the stenographic business entirely. Life is so terribly short, at best.

—*From the Montana "Center Line."*

• •

¶ In one of her lighter moments, says the office secretary, "Hotsi Totsi. I'm a Nazi."

• •

¶ Sadie: So you've got insomnia?

Sarah: Yes, and it worries. I can't sleep even when it's time to get up.

• •

¶ The old narrow trails where two cars could barely pass without colliding are happily being replaced by wide highways on which six or eight cars can collide at one time.

• •

¶ AIN'T ENGLISH FUNNY?

We'll begin with box, the plural is boxes.
But the plural of ox should be oxen, not oxes.
One fowl is a goose, but two are called geese,
Yet the plural of mouse is never meese.
You may find a lone mouse or a whole nest of mice,
But the plural of house is houses—not hice.
If the plural of man is always men,
Why shouldn't the plural of pan be called pen?
The cow in the plural may be called cows or kine,
But a bow, repeated, is never called bine.
And the plural of vow is vows, not vine.
If I speak of a foot and you show me two feet,
And I give you a boot, would a pair be called beet?
If one is a tooth and a whole set are teeth,
Why shouldn't the plural of booth be beeth?
If the singular's this and the plural these,
Should the plural of kiss ever be written keese?
We speak of a brother, and also of brethren,
But though we say mother, we never say methren.
Then the masculine pronouns are he, his and him,
But imagine the feminine she, shis and shim.
So the English, I think, you all will agree,
Is the funniest language you ever did see.

—*The Furrow.*

• •

¶ Up in North Dakota I learned about a queer phenomenum. It is Stump Lake. The lake got its name from the large number of big oak tree stumps on its bottom. The lake is now dry. Of course it must have been dry at some time in the historic past in order for those large oak trees to grow. The question on the minds of engineers in North Dakota now is, "Will trees grow in the lake bed again?" If they do then North Dakota is in for a long period of continued drouth. It would be well for highway engineers to consider climatic cycles. H. P. Gillette predicts many more years of declining precipitation.

• •

¶ For consolidating the end fill and backfiill of the Cheyenne River bridge, the Joyce Construction Co., Sioux Falls, S. D., who have the

contract, used a Barco gasoline tamper. This bridge is on U. S. 16 in South Dakota. Picture shows man working on east end.

• •

¶ Out in North Dakota they never use anemometers to measure the wind. They hang a log chain to a tall pole and measure the wind by degrees it makes with the pole.

All cars sold today are tested to meet every possible road condition on specially constructed test tracks.

American Road

WASHINGTON, D. C.

GEORGIA HIGHWAY CONTRACTORS

Down the Road

by CHARLES M. UPHAM
Engineer-Director,
American Road Builders' Association, Washington, D. C.

HEROES OF PEACE

Safety on the highways involves two important factors. First, the roads must be made safe for the driver. Second, the driver must be made safe for the roads. The three E's of highway safety—education, enforcement and engineering—take both these factors into consideration.

The science of engineering plays a major part in making motor vehicles as safe as humanly possible. Lack of sufficient funds prevents the major highway improvements recommended by highway engineers from being put into effect. No such consideration handicaps the automotive industry. Motor-vehicle manufacturers are cognizant of the fact that a high rate of traffic fatalities is a serious obstacle to their success and they have, therefore, made modern cars, trucks and busses well-nigh perfect from a safety standpoint. Engineers are equipped to do the same for the roads over which these machines travel.

Science has also turned its attention to the human factor in highway safety. Engineering joins forces with enforcement and education to reduce driver-responsibility for highway accidents. The Pennsylvania Turnpike, highway engineering's newest and most progressive feat and America's first real super-highway, has its counterpart in science's recent aid to the driver, the new Polaroid variable day glasses. We are all familiar with the dangers of night driving. The need for highway illumination to reduce after-dark accidents is universally recognized. Less obvious is the fact that too much light may sometimes be as dangerous as too little. Many daytime scenes are too bright for easy vision. Extraordinary brightness conditions that impair visual efficiency are common. While human sight is possible under extremely bright and extremely dark conditions, it is comfortable and efficient only over relatively intermediate stages. Dark glasses, conventional refuge for the cinema star who seeks escape from her fans, are also an important refuge for the motorist seeking escape from glare.

An ordinary pair of sun glasses, however, is not a complete answer to the motorist's problem. It must be remembered that the degree of brilliance of different outdoor scenes may vary in a large measure. A man driving toward the sun, for instance, has a different glare problem than the man with his back to it. With the brightness of surrounding objects varying, from 25,000,000 to 2 units on a clear day, it is evident that invariable glasses cannot be exactly right under all ordinary seeing conditions. Any device which is to bring these brightnesses within the comfort range of the human eye must itself have a wide range of flexibility. This is the peculiar advantage of the Polaroid variable day glass. It is the first anti-glare device that is adjustable to brightness variations.

The operation of these glasses is simple. Each eye looks out through two Polaroid lenses. The front lens is stationary in the frame, while the rear lens may be rotated by a convenient button on the bridge of the frame. When this control button is moved to the extreme left, the maximum amount of light reaches the eye, with reflected glare scientifically eliminated. As the button is moved towards the right, the glasses become gradually darker until they are so dark that the brightest possible surrounding landscape can be viewed with no discomfort. In effect, it is the equivalent of a whole series of conventional glasses, carefully graduated to pass different amounts of light. This feature makes them particularly adapted to motoring. On long automobile trips, the variables can be worn earlier in the morning and later in the afternoon than ordinary dark glasses. The men who developed Polaroid are enrolled in a peacetime army whose goal is human welfare. The scientists and engineers who work in laboratories and at drafting tables to save the lives of America's 30,000,000 motorists may well be labeled "heroes of peace."

GEORGIA HIGHWAY CONTRACTORS STAGE THIRD ANNUAL JAMBOREE

The Georgia Highway Contractors' Association staged its third annual Highway Jamboree at Lithia Springs, near Atlanta, September 26. Among the guests were Georgia officials, dignitaries from neighboring states and outstanding leaders in the nation's road-building industry and profession. Entertainment highlights included a barbecue, baseball game, golf tournament, horseshoe pitching contest and other field events. The American Road Builders' Association was represented by A. E. O'Brien, executive director, Highway Contractors' Division and executive secretary, Associated Pennsylvania Constructors, and Francis J. Kelly, ARBA general counsel. Paul L. Andrews, executive secretary of the Georgia affiliate, was in charge of arrangements.

ROUND-UP STAGED BY ILLINOIS AFFILIATE

A Road Builders' Round-Up was staged by the Illinois Road Builders' Association at the Aurora Country Club, Aurora, September 24. Entertainment included bridge, horseshoes, swimming and a golf tournament. Valuable prizes were awarded. General chairman for the all-day meet was Gil N. Bryan.

MAINE ROAD ASSOCIATION MARKS FIRST ANNIVERSARY

William C. Slee, assistant engineer-director, ARBA, discussed the importance of highways to national defense at the first annual convention of the Maine Good Roads Association at Poland Spring, September 14-15. More than 200 road builders and good roads enthusiasts attended the celebration which marked the end of the association's first year of activity. Col. Frank E. Southard of Augusta served as toastmaster for the banquet.

TEXAS AFFILIATE SPONSORS ANTI-DIVERSION AMENDMENT

A constitutional amendment against diversion of highway taxes to non-highway uses will be sponsored by the Texas Good Roads Association. Decision to work for such an amendment was reached at the

Builders' Review

OCTOBER, 1940

An ancient road book called the "Britannia Depicta" guided travelers more than 200 years ago.

HOLD THIRD ANNUAL JAMBOREE

September 9 meeting of the executive committee at Waco. This action would stabilize highway revenues and make possible a continued, long-range, well-planned Texas road program.

UNIVERSITY OF CALIFORNIA REORGANIZES ARBA CHAPTER

The University of California Student Chapter of the American Road Builders' Association has been reorganized under the sponsorship of Professor Bruce Jameyson, associate professor of civil engineering. Ninety-eight applications for student membership were received immediately following reorganization. The California group has been the ARBA's largest student chapter for the past several years.

CONTRACT SYSTEM URGED BY MICHIGAN AFFILIATE

Use of the contract system on all national defense projects was urged by the Michigan Good Roads Federation at a recent board of directors meeting in Midland. The ARBA affiliate pointed out that "experience has shown the economy and speed of the private contract system in the construction of roads, bridges, airports and other governmental projects." Copies of the resolution were sent to U. S. senators and representatives from Michigan, as well as to American Road Builders' Association officials for presentation to the War Department.

PAN-AMERICAN DIVISION PLANS NEW VOCABULARY

A new and extended English-Spanish technical highway vocabulary is being sponsored by the Pan-American Division, American Road Builders' Association. The committee appointed to compile this vocabulary includes representatives of the division, the Mexican Highway Department and the Engineering School of Mexico. The new edition is expected to have many improvements over the first vocabulary which was sponsored by the Pan-American Division several years ago.

Photographed during the August 26 preview of the Pennsylvania Turnpike are, left to right, Congressmen Frank W. Boykin of Alabama and Nat Patton of Texas, ARBA Engineer-Director Charles M. Upham, ARBA President Hal G. Sours, assistant director and chief engineer, Ohio Department of Highways; U. S. House Roads Committeemen James W. Mott of Oregon, Wilburn Cartwright of Oklahoma, committee chairman; and Jesse P. Wolcott of Michigan and Charter Heslep, city editor, "Washington Daily News." They are shown at the entrance to one of the seven tunnels which pierce the Allegheny mountains.

PRA PERSONNEL LISTED IN NEW ARBA BULLETIN

The personnel of the U. S. Public Roads Administration is listed in a new ARBA Statistical Division bulletin. Names and addresses of division chiefs, district engineers, regional chiefs, public roads representatives on federal work and highway planning representatives are included. PRA organization is also explained. Facts are given concerning the current highway program for the District of Columbia, as well as a list of the personnel of the District of Columbia Department of Highways. The 16-page booklet also contains the location of the national defense procurement areas. ARBA members can obtain copies by writing for Bulletin No. 62A.

FORTY ROAD DEPARTMENTS AID ARBA ECONOMICS DIVISION

Forty state highway departments are cooperating with the Highway Economics Division of the American Road Builders' Association. Reports and maps from state highway-planning surveys will be made available for division use. Many of these reports are near completion and several states have already sent in partial reports and maps of some counties. ARBA Engineer-Director Charles M. Upham points out, "This vast fund of information will be of the utmost value to our organization in its continued effort in the interest of the national highway program."

LIGHT WEIGHT SOILS USED IN HEAVY IDAHO FILL

Encounters Several Difficulties Which May Not Yet Be Corrected

By JOHN A. WEST
Soils Surveyor
Idaho Bureau of Highways

OVER the summit, on the Payette River, is the little village of Horseshoe Bend. That's why the project was called Horseshoe Bend Hill. To get there from Boise, Idaho, drive west on State Route 15, which turns north a few miles west of town. The line layout illustrated in Fig. 2 shows the project starting about Spring Valley and ending on the summit. Technically it is known in Idaho as F.A.P. 129A(3) and F.A.P. 129B(2). It was let in two sections to Dan J. Cavanaugh, a contractor from Twin Falls, Idaho. The project is described because of the variable soils and rock through which it passed, because of the stage design, and because of the troubles encountered. One hesitates, often, to tell about the difficulties encountered on a construction project. Those met here were solved or corrected with the exception of the base protection coat which must be corrected before winter sets in.

Design

Many different types of materials were encountered in the soil survey made along the proposed line. A soil profile was plotted as shown by Fig. 1. The various soils encountered were analyzed and studied in the laboratory. These studies resulted in recommendations to the Design Department regarding the method of embankment construction, the removal of unsuitable soils at 0.0 grade points, the quantity of water for compaction, the manipulation and combination of materials for the base, and the road oil protection. The soils varied in dry weight per cubic foot from 70 lb. to 128 lb. Some rock was encountered and some of the soils, while as hard as rock, were broken up with a heavy ripper. An RD8 Caterpillar tractor was required to pull the new three tooth Le Tourneau ripper.

The cross section design is shown by Fig. 4, on which it will be noted, two thicknesses of base course were used. Stage construction calls for a 2½ in. future oil mat wearing surface. Base course on the light weight soils included all of the 12 in. thickness and part of the 8 in. The backslopes built by the contractor were rounded on top; no intercepting ditch was constructed, but the cross-section could not be streamlined because of the mountainous

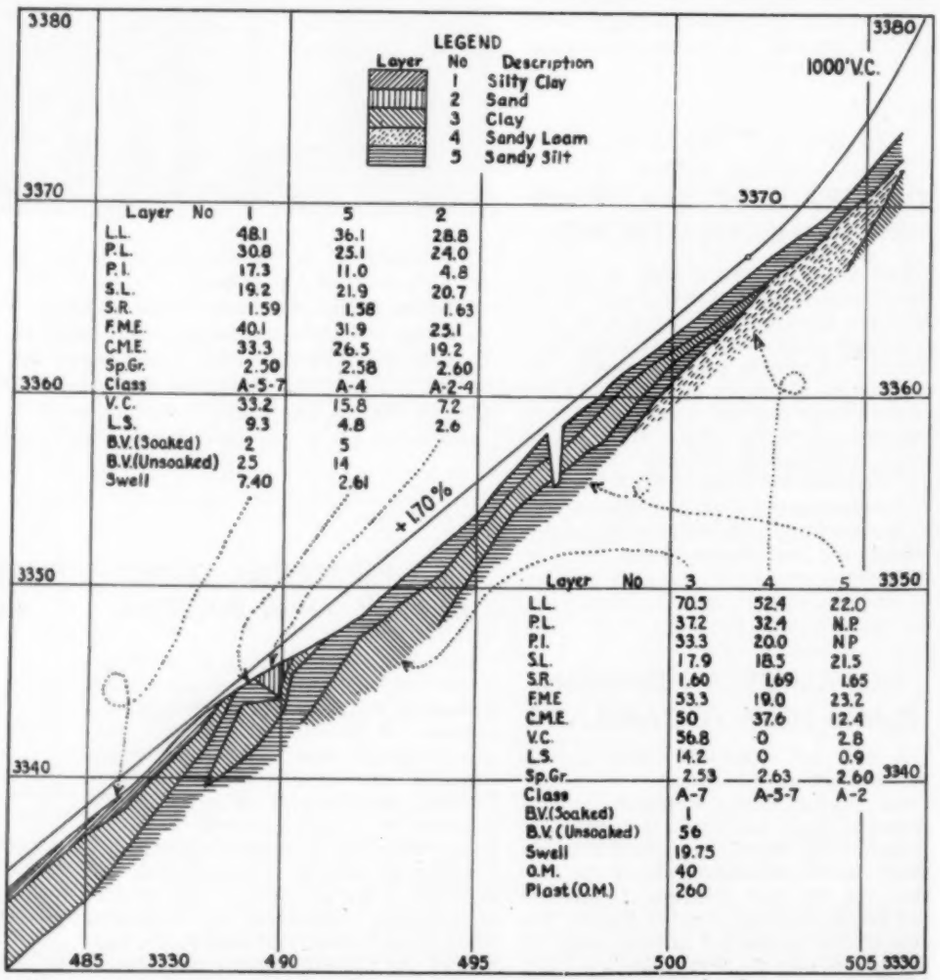


Fig. 1.—Short Section of Soil Profile. A Profile Was Not Run on the Entire Project. This Was the First Project in Dist. A on Which Idaho Employed Embankment Control

STRENGTH

...to finish whatever it starts.

...to rip through toughest going.
...to ram the dipper deep into the bank.
...to resist twisting and fracturing.
...to absorb shock loads.
...to pile up profits for you.

11 Fully convertible models in 3/8-1/2-5/8-3/4 yd. sizes

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canyon through which the road passes. The backslope identifications Sch. No. 1 and Sch. No. 2 refer to the items of excavation labeled Schedule 1 and Schedule 2. Excavation was divided into these two schedules for taking bids. Schedule 1 was established by stations to include known rock conditions. However, relatively speaking, the contractor encountered more difficulties with the lighter weight soils of Schedule 2.

All curves were widened and superelevated as shown by Fig. 3, which also shows how fills over 5 ft. high were widened. Idaho does not design curve transition spirals into the line.

An idea of the amount of improvement is obtained by reference to the following table:

Length—	
Old alignment	4.334 miles
New alignment	3.575 miles
Shortened by	0.759 miles
Central angle curvature—	
Old alignment	1,591 degs. 43 min.
New alignment	714 degs. 43 min.
Decreased by	877 degs. 9 min.
Curves—	
Old alignment	41
New alignment	17
Eliminated	24
Max. on old alignment	24 degs.
Max. on new alignment	14 degs.
Grades—	
Max on new same as on old alignment	7 per cent

There were no major bridge structures on the 3.575 miles of new project, drainage being handled by corrugated metal pipe culverts up to 48 in. in diameter and one 75 in. corrugated multiplate culvert. This 75 in. culvert had concrete headwalls built onto it.

Grading

Tractors and scrapers were used by the contractor to begin the work. Later a ¾ yd. Marion power shovel, with a new Allis-Chalmers engine installed, and 1½ ton trucks were added as another outfit. With the scraper outfit a heavy three-tooth ripper was found necessary to break up the hard, tough soil. The bulldozer was used as a pusher to load the scrapers. The shovel and trucks were used in rock, on a small channel change, and to remove the large slides that occurred. The tough, hard soil, when broken into small chunks readily pulverized under the compaction roller.

The first difficulty encountered was one that would naturally develop from the specification for compaction that governed. One paragraph read as follows:

"In the event that heavy Le Tourneau scrapers or other equally heavy grading equipment is used and is routed over the full width of the fills, as directed, this method of compaction may serve in lieu of rolling, the Engineer to be the judge."

The contractor, naturally enough, would not purchase a compacting roller if he could avoid it, since that would mean the purchase of another tractor also, plus the expense of operating it. Had the soils been uniform and of good classification this paragraph would have been completely satisfactory. Unfortunately (or maybe fortunately) the contractor started work on the section containing the lightest weight soils. In placing the fill he deposited the soil in layers 4 in. thick or less and, as practicably as possible, traveled over loose soil. Field tests showed the resulting compaction, during the first week of operation, to be unsatisfactory. The specifica-

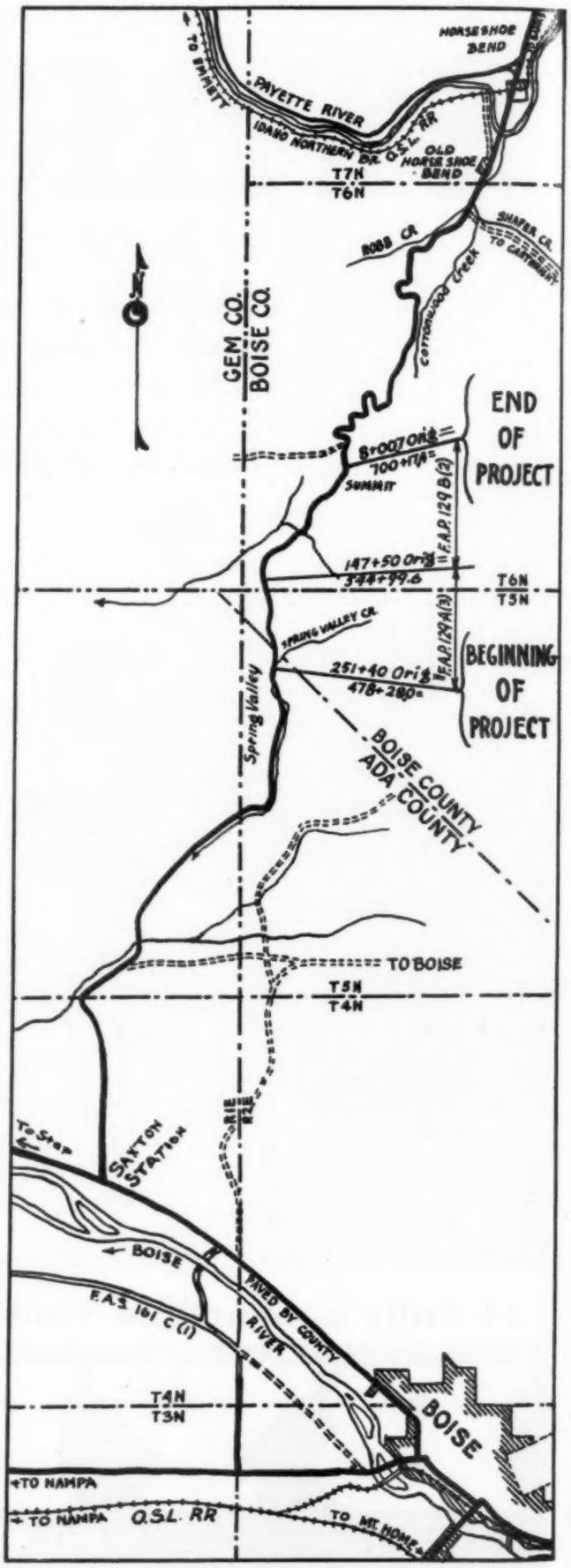

Fig. 2.—Line and Location of Horseshoe Bend Project

For Heavy Duty

Brick has always been preeminent as the heavy duty pavement. Its hardness and toughness protects the base of the road from traffic damage and weather destruction. That's why brick pavements will serve all phases of our national life for 30-50 years. National Paving Brick Association, National Press Building, Washington, D. C.

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FOR NEW OR RESURFACE JOBS

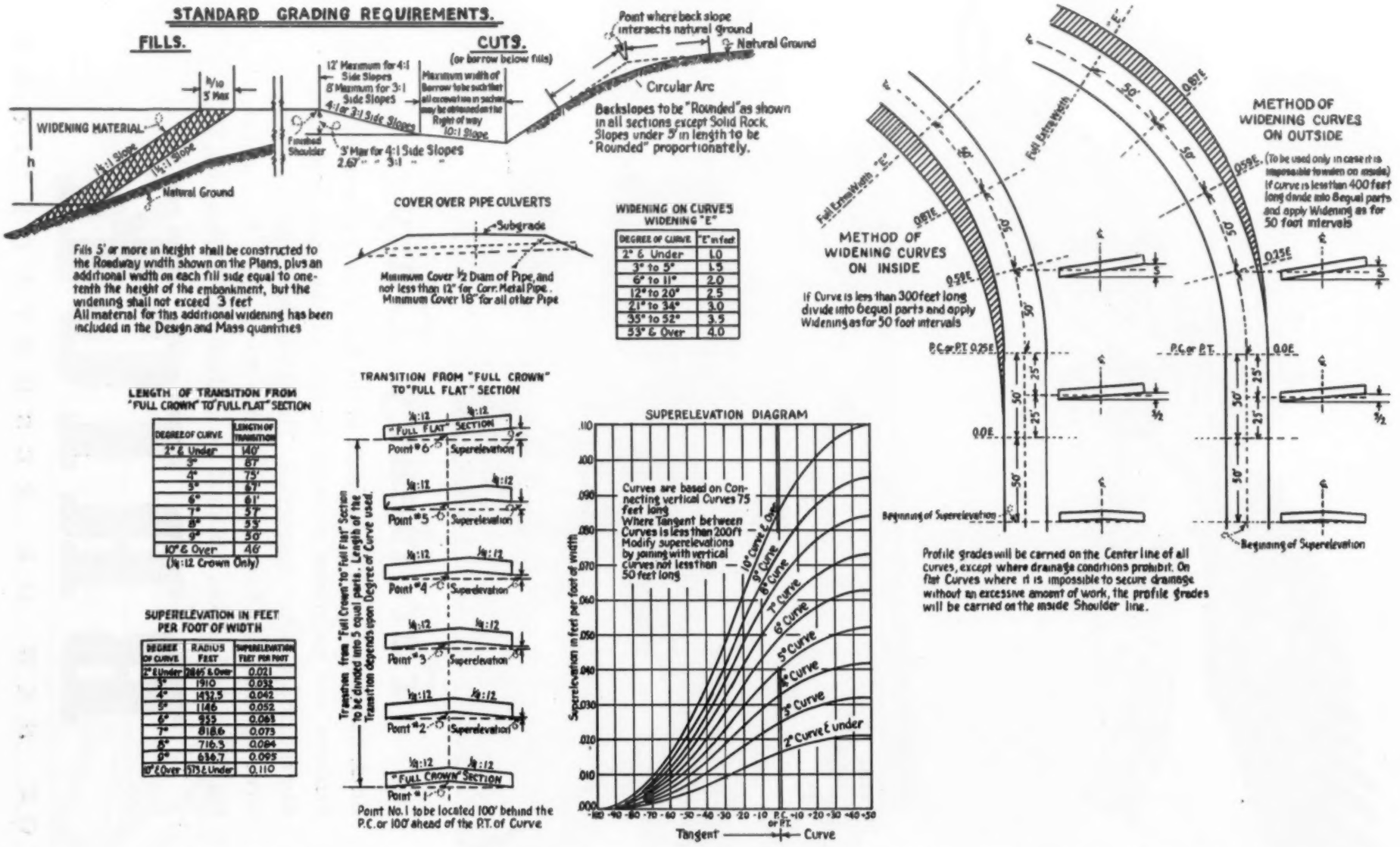
STANDARD GRADING REQUIREMENTS.
FILLS.
CUTS.
(or borrow below fills)
WIDENING MATERIAL
h/10
5' Max
1½:1 Slope
1½:1 Slope
Natural Ground
Finished Shoulder
12' Maximum for 4:1 Side Slopes
8' Maximum for 3:1 Side Slopes
4:1 or 3:1 Side Slopes
3' Max for 4:1 Side Slopes
2.67" " 3:1 " "
Maximum width of Borrow to be such that all excavation in section may be obtained on the Right of way
10:1 Slope
Point where back slope intersects natural ground
Natural Ground
Circular Arc
Backslopes to be "Rounded" as shown in all sections except Solid Rock. Slopes under 5' in length to be "Rounded" proportionately.
Fills 5' or more in height shall be constructed to the Roadway width shown on the Plans, plus an additional width on each fill side equal to one-tenth the height of the embankment, but the widening shall not exceed 3 feet
All material for this additional widening has been included in the Design and Mass quantities
COVER OVER PIPE CULVERTS
Subgrade
Minimum Cover ½ Diam of Pipe, and not less than 12" for Corr. Metal Pipe.
Minimum Cover 18" for all other Pipe
WIDENING ON CURVES
WIDENING "E"
DEGREE OF CURVE
"E" in feet
2° & Under 1.0
3° to 5° 1.5
6° to 11° 2.0
12° to 20° 2.5
21° to 34° 3.0
35° to 52° 3.5
53° & Over 4.0
LENGTH OF TRANSITION FROM "FULL CROWN" TO "FULL FLAT" SECTION
DEGREE OF CURVE
LENGTH OF TRANSITION
2° & Under 140'
3° 87'
4° 75'
5° 67'
6° 61'
7° 57'
8° 53'
9° 50'
10° & Over 46'
(⅛:12 Crown Only)
SUPERELEVATION IN FEET PER FOOT OF WIDTH
DEGREE OF CURVE
RADIUS FEET
SUPERELEVATION FEET PER FOOT
2° & Under 2865 & Over 0.021
3° 1910 0.032
4° 1432.5 0.042
5° 1146 0.052
6° 955 0.063
7° 818.6 0.073
8° 716.5 0.084
9° 636.7 0.095
10° & Over 573 & Under 0.110
TRANSITION FROM "FULL CROWN" TO "FULL FLAT" SECTION
⅛:12
"FULL FLAT" SECTION
Point #6
Superelevation
Point #5
Point #4
Point #3
Point #2
"FULL CROWN" SECTION
Point #1
Transition from "Full Crown" to "Full Flat" Section to be divided into 5 equal parts. Length of the Transition depends upon Degree of Curve used.
Point No. 1 to be located 100' behind the P.C. or 100' ahead of the P.T. of Curve
SUPERELEVATION DIAGRAM
Curves are based on Connecting vertical Curves 75 feet long
Where Tangent between Curves is less than 200ft Modify superelevations by joining with vertical Curves not less than 50 feet long
Superelevation in feet per foot of width
10° Curve & Over
9° Curve
8° Curve
7° Curve
6° Curve
5° Curve
4° Curve
3° Curve
2° Curve & under
P.C. or P.T.
Tangent
Curve
METHOD OF WIDENING CURVES ON INSIDE
Full Extra Width "E"
Full Extra Width
0.67E
0.25E
If Curve is less than 300 feet long divide into Bequal parts and apply Widening as for 50 foot intervals
P.C. or P.T.
0.75E
0.0E
Beginning of Superelevation
METHOD OF WIDENING CURVES ON OUTSIDE
(To be used only in case it is impossible to widen on inside)
If curve is less than 400 feet long divide into Bequal parts and apply Widening as for 50 foot intervals
Profile grades will be carried on the Center line of all curves, except where drainage conditions prohibit. On flat Curves where it is impossible to secure drainage without an excessive amount of work, the profile grades will be carried on the inside Shoulder line.

Fig. 3.—Methods for Widening and Super-elevating Curves, Widening High Fills, Rounding Back Slopes, and Limiting Depth of Side Ditches

● Throughout the snow belt, States, Counties and Cities are finding the A-W "99" their one best bet for quick, economical, dependable snow removal. No motor grader ever built even approaches the "99" Power Grader in its ability to handle snow. With powerful traction on the front wheels immediately behind the "V" plow, and with steerable rear wheels, the "99" bucks through the biggest drifts, overcomes side-draft, reduces skid hazards, and doesn't tend to slide into the ditch.

Superior snow fighting ability is but one of many of the "99's" outstanding advantages. The unmatched traction and directional control of this ALL-SEASON power grader adds an "extra working month each year" because it moves more material farther and faster . . . will work efficiently in rough, wet or sandy ground where other motor graders cannot even go through with blade empty . . . and is in a class by itself on (1) ability to work on narrow, winding roads and around sharp curves; (2) work on steep slopes; (3) handle fine grading with speed and precision; and (4) operate attachments mounted both ahead and behind.

Write for full details, or call nearest A-W Distributor for a convincing demonstration. THE AUSTIN-WESTERN ROAD MACHINERY CO., Aurora, Illinois.

Motor Graders
Loaders
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Crushing and Screening Plants

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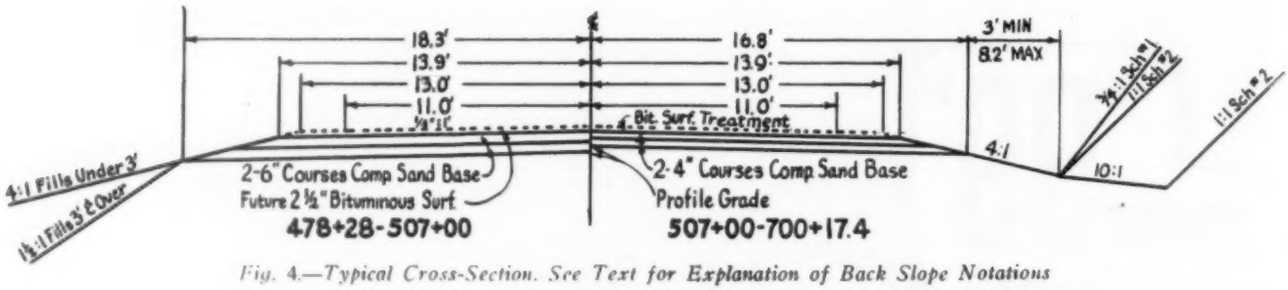


Fig. 4.—Typical Cross-Section. See Text for Explanation of Back Slope Notations

tions required the following compaction results on the various soils:

Maximum Dry Weight, lb. per cu. ft.	Rating AASHO	Minimum Field Compaction Requirements, Per cent of Max. Dry Weight
99.9 and below	Unsatisfactory	.....
100.0 to 109.9	Very poor	100
110.0 to 119.9	Poor	95
120.0 to 129.9	Fair	90
130.0 and above	Good	90

These are the standard A.A.S.H.O. specifications for compaction of fills exceeding 10 ft. in height. Such fills may be placed on steep sloping foundations, or in places subject to long periods of inundation. On this project, there are no periods of inundation but there were many steep sloping foundations and many fills over 10 ft. in height. The contractor started work on the poorest soil which, according to the specifications, should not have been used. Because of the cost of hauling in satisfactory materials the state decided to do the best it could with the soils encountered, so the 70 lb. soil had to be used. The first work fell short of the required compaction, so the outfit was moved to a new cut until the contractor could obtain a compaction roller unit. The new cut was sandy and compacted readily to the desired density as referred to the Proctor density obtained by the laboratory.

Idaho used a modified Proctor mold. It is 1/20 cu. ft. instead of the Proctor 1/30 and has slightly tapered sides so that the compacted sample may be easily forced out. A screw press is used for forcing the specimen out of the mold.

A field report of the first week's embankment construction is given in Table I.

By this report it can be seen that required compaction was not being obtained. After the sheepsfoot roller was obtained the densities on the balance of the fill improved greatly as is indicated by the subsequent field report

Fig. 5.—Showing Typical Cut and Fill Sections

(Table II) for the same fill as it neared the embankment grade line. By changing the clause in the specifications about no extra rolling equipment being needed, the state now requires rolling on all work.

In this case, the engineer exercised his authority as

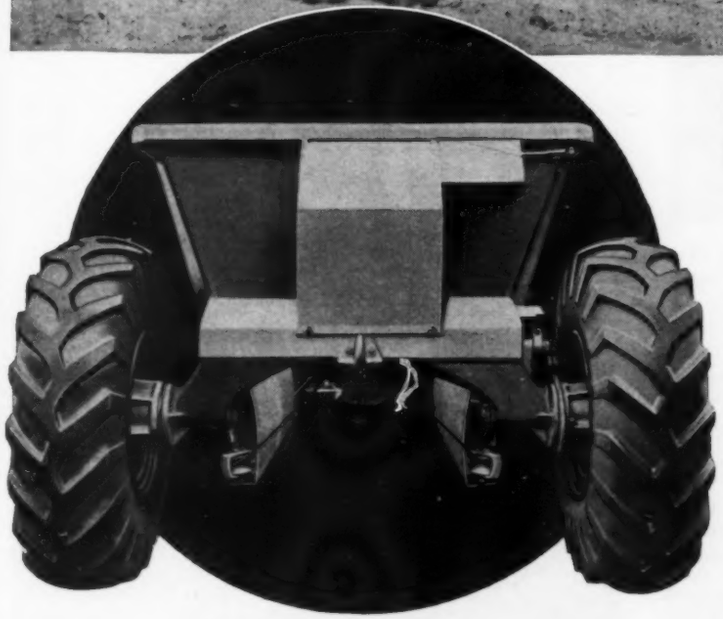
Fig. 6.—Some of the Cuts Were Very Heavy Going. Bulldozer Is Used as a Pusher. This is a Spring Mud Condition

TABLE I—PROJECT No. 129A(3)-B(2)—REPORT No. 1

Report on Compaction of Earthwork Week Ending 12-16-39

Station	Elev.	Spec. Gr.	Standard Compaction D_s	Fill Density D_f	% Vol. Occupied by Solid	% Vol. Occupied by H_2O	% Vol. Occupied by Air	Actual Water Content Compacted, Per cent	Per cent Compaction
535	—28	2.62	80.5	77	47	38	15	31	96
539	—19	2.62	80.5	78	48	36	16	29	97
539 + 25	—17	2.62	80.5	68	42	36	22	33	84
538	—18	2.62	80.5	74	45	26	29	22	91
541	—10	2.62	80.5	71	43	32	25	28	88
559 + 86	—20	2.79	82.0	89	51	44	25	31	108
540	—11	2.42	80.5	64	42	34	24	33	81
534	—7	2.42	75.0	72	48	29	23	25	96
533 + 50	—12	2.42	75.0	65	43	29	28	28	87
539	—16	2.42	75.0	65	43	35	22	34	81
540 + 75	—11	2.42	75.0	70	47	35	18	31	87
559 + 60	—22	2.90	73.0	91	50	28	22	19	80

SAVE SECONDS *on the fill!*



Maximum ground clearance of open doors, and high arched rear body construction, provide sufficient load clearance when dumping. Doors are curved for maximum strength. Free swinging, gravity impelled doors are released instantly for dumping.

EVERY SECOND SAVED . . . REDUCES HAULING COSTS

Instantaneous dumping of the load—exactly where it is wanted—at traveling speed, saves time on *every trip.* The Koehring Trail-Dump high arched, rear body construction with free swinging, gravity impelled doors, permits "getting off the load" without reduction of traveling speed. Doors are curved and well reinforced to provide maximum strength. Dumping lever—conveniently located—releases doors instantly — also engages mechanically simple "automatic hand" for positive door closing. "Automatic hand" stops operating automatically when doors are closed or become jammed with large stones or frozen dirt.

KOEHRING COMPANY • MILWAUKEE, WISCONSIN

KOEHRING HEAVY DUTY

HEAVY-DUTY CONSTRUCTION EQUIPMENT

TABLE II—REPORT No. 11

Report on Compaction of Earthwork Week Ending 5-4-40

Station	Elev.	Spec. Gr.	Standard Compaction D_s	Fill Density D_f	% Vol. Occupied by Solid	% Vol. Occupied by H_2O	% Vol. Occupied by Air	Actual Water Content Compacted, Per cent	Per cent Compaction
532	—3.0	2.62	80.5	73	45	30	25	26	91
531	—5.0	2.62	80.5	82	50	39	11	30	102
531 + 80	—5.5	2.62	80.5	75	46	38	16	32	94
533 + 55	—2.0	2.62	80.5	60	37	29	24	30	75
532 + 80	—1.5	2.62	80.5	73	45	32	23	27	91
531	—7.0	2.62	80.5	84	52	39	9	29	104
531	—4.0	2.62	80.5	85	52	26	22	19	106
531 + 40	—2.0	2.62	80.5	75	46	36	18	30	93
531 + 50	00	2.62	80.5	80	49	37	14	29	100
533 + 10	00	2.65	88.1	95	58	29	13	19	107
530 + 50	—1.8	2.65	88.1	91	55	29	16	20	103

"the judge" as to whether or not compaction was satisfactory with hauling units, and required the contractor to add the compacting roller equipment.

On those fills built over old embankments, the contractor benched the side slopes of the old embankment. That is as he built up the grade about 5 ft. in height he would bulldoze a bench out of the old fill about 3 ft. wide. This gave about a 5 ft. vertical face. Thus the new fill was lapped by a series of steps onto the old fill.

Fig. 7.—Power Shovel Used Part of Time on Cuts, Part of Time on Slides, and Part of Time on Channel Change. Light Trucks Used for Hauling

About the time the compaction difficulties were being overcome, a huge slide slowly crept down over the roadway. It had to be removed periodically at about hourly intervals to permit passage of traffic. Several slides occurred during grading operations. The power shovel and trucks were used for removing these.

Fig. 8.—Sprinkling Water Spread by Open Spout Playing on a Flat Plate

Fill compaction water was paid for at the rate of 50c per 1,000 gal. The contract was let in the fall so the state could obtain the benefit of fall and spring rains as well as melting snows over the cut faces to get necessary compaction water. The contractor quit operations about Dec. 30, 1939 and resumed about March 10, 1940. He finished grading about May 18, 1940.

After completion of the grading work, Resident Engineer C. P. Varian, computed the average compaction results as shown by the following table:

Station to Station		Per cent Compaction High	Low	Average
479 + 00	508 + 00	88	67	82.6
510 + 00	517 + 00	101	78	90.0
517 + 00	530 + 00	106	62	83.8
530 + 00	536 + 00	109	70	91.9
538 + 00	541 + 00	105	67	89.5
553 + 00	599 + 00	110	80	94.7
612 + 00	623 + 00	110	82	96.8
626 + 00	634 + 00	104	90	97.5
639 + 00	645 + 00	99	81	92.5
647 + 50	649 + 50	104	83	95.5
650 + 00	655 + 00	102	80	99.0
660 + 00	663 + 50	97	89	93.9
668 + 00	669 + 50	110	94	102.3
678 + 00	681 + 00	102	83	94.2
685 + 50	690 + 00	99	87	93.6

Base Course

As stated previously the base course was designed with two different thicknesses. From Station 478+28, the beginning of the project to Station 507+00 the 12 in. base was laid and rolled in two lifts. This is over the light weight soils section. From Station 507+00 to the end of the project, Station 700+17.4, the base course of 8 in. thickness was also laid and rolled in two lifts.

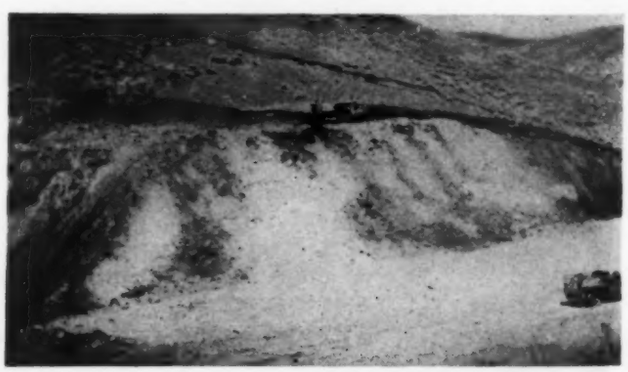
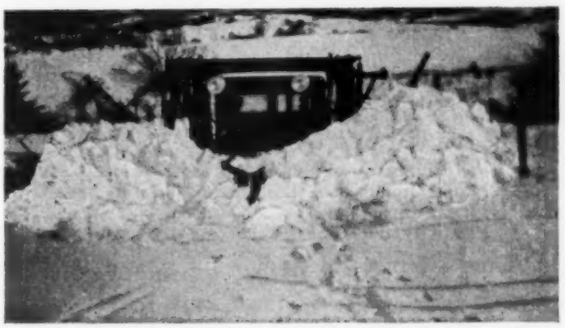


Fig. 9.—Relative Size of Slide Noted by Size of Bulldozer Working on Top of Cut Slope. Outline of Slide Indicated by Crack in Earth. It was 12 Ft. Deep and Cut was Nearly Finished When Slide Occurred

Superior equipment is essential to win wars. Snow removal from streets and highways presents a tough battle unless you use sturdy, dependable plows.

Baker Snow Plows are built to conquer Old Man Winter's worst blitzkriegs year after year, quickly and efficiently. They are the result of 32 years of experience in building snow plows to meet every need.

Twenty-one models of truck snow plows to select from, including those with sectional tripping blades, originated by Baker. One-way plows that really throw off the snow. Sleek, stream-lined "V" plows in a new series, built for any motor truck. New hydraulic plow lifts that are easier to mount on your trucks. It will pay you to investigate the advantages of Bakers.



Baker also builds snow plows for large and small tractors of many makes in "V" and blade types, including side-walk plows of new design. Give names and models of tractors you have available for snow removal.

THE BAKER MANUFACTURING CO.

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BAKER SNOW PLOWS

Fig. 10.—Making Fill Density Test With Sand. Small Paint Brush in Left Hand Is Used for Smoothing Off Top of Sand

The material was a mixture of two sources combined in the ratio of 85 per cent of decomposed granitic sand, called granodiorite, and 15 per cent binder soil. Following is a typical analysis of the mixture:

Mesh Sieve	Per Cent Passing Granite Sand	Soil Binder	Stabilized Mixture
1 in. sq. mesh	100	.....	100
¾ in. sq. mesh	99	.....	99
½ in. sq. mesh	98	.....	98
¼ in. sq. mesh	93	100	94
No. 6	80	96	82
No. 10	64	89	67
No. 20	39	75	44
No. 30	31	68	36
No. 40	22	61	28
No. 50	16	52	22
No. 100	8	36	12
No. 200	4	25	7
Cementing value, lb./sq in.	28	437	3.58
Swell, per cent	0.0	.....	.....
Plasticity, index	0.0	15.8	0.0

The soil test data on the binder soil are as follows:

Field moisture equivalent	37.9
Liquid limit	39.1
Linear shrinkage	5.2
Plasticity index	15.8

After mixture, the following typical data were obtained:

Field moisture equivalent	26.2
Liquid limit	28.0
Plasticity index	0.0

The granite sand deposit contained 8 to 9 per cent moisture, and about 6 per cent water was added during construction. This was done by sprinkler tanks and the roadmix method. In preparing the mixture, the engineers endeavored to obtain a cementing value of not less than 125 lb. per sq. in. and a P. I. of 3. It will be noted that the cementing value obtained ran around 350 to 400 lb. per sq. in. and the P. I. was 0.0. In this case the liquid limit requirement controlled the mixture.

It was difficult to hold the mixture on the steep grades for rolling during construction. For this purpose a 10-ton, 3-wheeled roller was used. The surface was continually dragged to keep corrugations from developing during rolling.

After completion of placing of the base course, it was discovered that the quantities used exceeded the quantities estimated by approximately 30 per cent. An explanation of this was found in the fact that when the binder soil was added the mixture compacted to a greater density than the granodiorite, alone, as it was found in the pit.

The granite sand was first windrowed in required amount and spread out with a motor grader to the width of the opening of the scrapers. The scrapers hauled the binder soil from roadside cut and spread the required amount in a thin layer over the sand. Then motor graders road mixed the material. Water was added and the windrows passed back and forth until the mixture was ready to spread.

Abrasion Coat

The project is planned for stage construction. The mat coat, designed for 2½ in. thickness, will not be placed until some future date. In the meantime, to protect the base course, it was covered with a bituminous surface treatment.

After the base course was thoroughly rolled, a prime coat of SC 1A was applied at the rate of 0.4 gal. per sq. yd. Most of the fills have been widened in accordance with the plans, but the prime coat was applied only over the width of the roadbed. The base course did not cover the full area of the widened fills.

The weather was cold so another difficulty was encountered. The prime coat did not penetrate as expected. After it was applied it chilled before penetrating. A day or so later a cold rain, and snow near the summit, fell. When the surface dried off it was covered with a sand seal. SC3 was applied at the rate of 0.2 gal. per sq. yd. and blotted with the granitic sand. Shortly after the job was opened to traffic, the seal coat scabbed off in many places, indicating that the prime coat had not penetrated and that both the prime and the seal were applied under adverse weather conditions. Not only did the seal coat scale off in many places, but it also corrugated.

The road surface has the appearance of one that has been in service beyond its serviceable life. Correction is expected by the end of the year to overcome this last difficulty. The surface will be reworked and new seal coat applied.

It remains to be seen how well the light weight soil fills will stand up under weather and traffic.

Equipment List

1—¾-yd. power shovel, Marion with Allis-Chalmers power unit.
5—1½-ton trucks on grading—Ford V8.
18—1½-ton trucks on surfacing base—Ford V8's with 1—6 yd. International and 1—5 yd. Diamond T.
3—12-yd. scrapers, Le Tourneau.
1—20-yd. scraper, Le Tourneau.
2—Rippers, Le Tourneau (used only one).
1—Twin-tandem sheepsfoot roller, Le Tourneau.
1—Bulldozer.
5—Crawler tractors, Caterpillar, RD8.
1—Crawler tractor, Caterpillar, D6.
2—Tanks, water, 1100 and 1200 gal.
1—Motorgrader, Caterpillar No. 12.
1—Roller, 3-wheel, 10-ton, Austin-Western.
1—Spreader, 10-ft., Buckeye.
1—Pump, centrifugal 2½-in., Jaeger.
1—Compressor, 660 ft., Sullivan.
Some old model tools and units.

Particular attention was given to wire rope to be sure that preformed was used.

Personnel

Both sections of the contract were constructed by Dan J. Cavanaugh, Contractor, Twin Falls, Idaho. He sublet the bituminous work to Morrisen-Knudsen Co., Boise, Idaho. The superintendent for Cavanaugh was Clarence Webb.

For the state, C. L. Varian was Resident Engineer; P. E. Oxley, District Engineer; and C. P. Humphrey, State Highway Engineer. The soils engineer, John A. West, and the materials engineer, C. C. Hallvik, supervised the soils and materials testing. For the district office, Henry Lacey is District Materials Engineer.

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....A mile or more of subgrade trench per day with one machine!

WITH Buckeye Road Widening Machines you can dig a clean, true subgrade trench of uniform width and depth at a cost way below inefficient hand digging and at a speed way in excess of it. These easily operated, ruggedly built machines are comparable in quality and efficiency to all the well-known Buckeye Trenching Machines. Built in two models, they will handle any widening job. Model 16-R—mounted on 1½-ton Ford or Chevrolet chassis, digs trenches 12 to 27 inches wide. Model 16-R-4 can be mounted on new or used trucks of 3 tons capacity or more—digs trenches 12 to 48 inches wide. Wider trenches can be dug by taking more than one cut.

Digging assembly swings in back of truck for transportation, and may be completely removed if truck is needed for other purposes. For faster, better, lower cost road widening, put a Buckeye on your next job. Write for literature now.

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DEVICE FOR MEASURING DEGREE OF CURVATURE

By JAMES S. BURCH and WAYT THOMAS
North Carolina State Highway Commission

IN MAKING a survey of the excess curvature on roads in North Carolina, it was found that on 1,220 miles of main highways, there were no plans from which the degree of curvature could be taken. It, therefore, seemed advisable to develop a device by which these curves could quickly be measured in the field.

A study was made of existing devices, particularly of the Arkansas device consisting of a one-wheel trailer, described in Public Roads Administration News Bulletin No. 11, which seemed to meet requirements for accuracy; the Ohio device, which seemed to embody the requirements of convenience, described in memorandum to Bureau Managers, Public Roads Administration, dated June 11, 1936, and the Arizona device, which has some of the elements of both. (This is described in H.P.S. Memo. No. 134, dated November 4, 1936).

Advantages To Be Provided

A North Carolina type curvemeter was developed to provide the following advantages:

1. The instrument is mounted on a standard touring car which may be driven, moved about and parked as one would an ordinary automobile. There is no trailer attached.
2. With ordinary care in operation, a degree of accuracy may be obtained within 1 degree of curvature, on curves no sharper than about 15 degrees.
3. May be operated with a 2-man party; consisting of one driver, and one observer recorder.
4. Since the device is actuated by the regular Pittman arm shaft on the car, the lost motion in the worm gear of the steering mechanism is eliminated.
5. The lost motion take-up practically eliminates other lost motion.
6. Face of instrument dial directly in front of observer's seat, leaving driver free to give full attention to holding the car on the curve.
7. Indicator needle moves to right on curves to right, and to left on curves to left.
8. Side way of car due to superelevation and centrifugal force is eliminated by stabilizer, which holds body on frame during survey operations.
9. Stabilizer may be operated or disconnected within one minute without either driver or observer getting out of their seats. Thus during idle driving, normal car springs function fully.

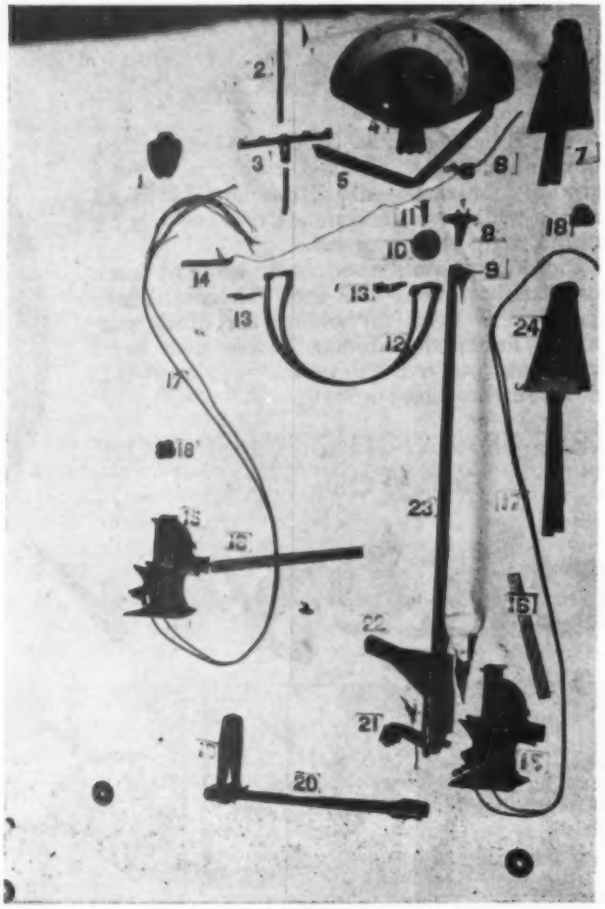


Fig. 1.—Parts of Curvemeter

Fig. 2.—Rear Stabilizer Sheaves, Sheave Support and Jack Support Assembly

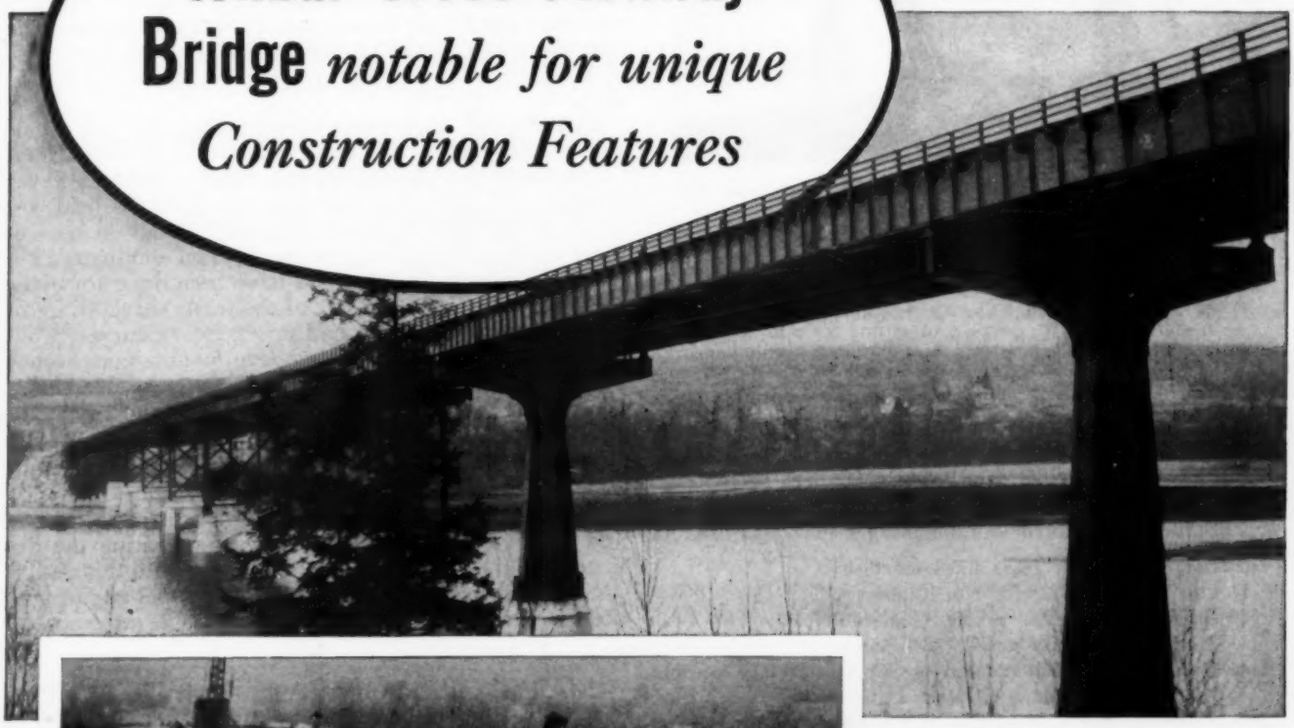
DETAILS OF ASSEMBLY

The following is a list of the component parts of the device as shown in Fig. 1:

1. Windshield compass (not a part of curvemeter).
2. Front sight rod mounted on left front fender.
3. Rear sight rod and sight cap on which are five points, either of which may be used in sighting the center line, permitting

Wilbur Cross Parkway Bridge *notable for unique Construction Features*

Built for the State of Connecticut, under the direction of the State Highway Department.



THREE CONTINUOUS PLATE GIRDER UNITS — *256, 384 and 640 feet long—combined with a 544-ft. cantilever unit, comprise the Wilbur Cross Parkway Bridge. The cantilever unit (at the right of photo) is supported by two T-type bents of cellular construction, the stems of which are rigidly anchored to single cylindrical piers. Bridge piers are founded on H Bearing Piles and reinforced with U·S·S Reinforcing Bars furnished by Carnegie-Illinois Steel Corporation.*

WELDING *Carnegie-Illinois 5-inch I-Beam-Lok open type flooring on south 26-ft. roadway; part of the north roadway is seen at the extreme left of photo. Three lines of longitudinal plate girders support the two roadways; outside girders are spaced 59 feet on centers. Exposed top flanges framed with bent side plates form the roadway curb.*

SPANNING the Housatonic River near Milford, the Wilbur Cross Parkway Bridge provides the connecting link between Connecticut's famous Merritt Parkway and the Boston Post Road.

Besides typifying the modern trend to continuous and cantilever plate girder design, this bridge has the further distinction of utilizing two unique T-type steel bents for supporting the cantilever superstructure.

Through the use of these ingeniously devised T-bents on single, centrally aligned, cylindrical piers, a minimum span length of 224 feet was sufficient to provide the 150 ft. navigation clearance specified for the 54-degree-skewed ship channel.

The 1284 foot length of this modern viaduct is composed of 12 plate girder spans varying in length from 128 to 224 feet. Nine rectangular, transversely braced steel bents of conventional design, in addition to the special channel bents, support the three lines of longitudinal girders that carry two 26-foot separated roadways of open type I-Beam-Lok construction. It is built on a 3 per cent grade and provides a 90-foot clearance above mean low water.

The entire superstructure, including the structural railings of beam and channel type, was fabricated and erected by American Bridge Co.

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UNITED STATES STEEL

Fig. 3.—Interior Curvemeter Car, Showing Dial Scale and Indicator (Arrow)

car to maintain proper distance from road center line stripe while measuring any curve on any width pavement.

4. Assembly of graduated dial scale (adjustable with reference to scale support for purpose of setting scale to zero under dial when car is going in a straight line); scale support; upper bearing and bearing support.
5. Scale support brace.
6. Indicator (counter-balanced and fixed to small spur gear).
7. Superelevation meter (not a part of the curvemeter).
8. Lower spur gear keyed to hollow shaft (23) and primary spindle.
9. Number 2 tapered key for connecting primary spindle to hollow shaft.
10. Large and small gears fixed together.
11. Cap screw for axle for No. 10 above.
12. Guard for indicator needle (removable).
13. Strap iron slots for guard (12) support.
14. Coiled steel spring attached to 100 lb. test line for lost motion take-up.
15. Stabilizer jack (one shown) ordinary auto jack.
16. Handles for stabilizer jacks.
17. ¼ in. diameter flexible cable for stabilizer.
18. ¼ in. cable clamp.
19. Auxiliary Pittman arm for actuating curvemeter indicator.
20. Special length connecting rod.
21. Bell crank arm for actuating hollow shaft.
22. Lower bearings and bearings support.
23. Main hollow shaft (a ⅜ in. extra heavy pipe).
24. Clinometer or grademeter (not a part of curvemeter).
27. Rear sheave and jack support (separate photo, see Fig. 2).

Tests.—The development of any new device will present problems which must be solved before successful operation may be attained. On the first trial operation it was found that the indicator was not sensitive enough. Gears were added that would step up the length of travel by six and two-thirds times. In order ot calibrate and later test the instrument, a 17-mile stretch of road was selected on which the degree of the curves were known. The calibrations were made empirically. On the first test, it was found that the instrument indicated a different reading for different speeds on the same curve; and that on curves of the same degree, one having maximum superelevation and the other having no superelevation that the instrument would indicate that they were of different degree. This difference was attributed to the effect of the side sway of the car on the instrument. A stabilizer was then devised to offset this difficulty. On test with the stabilizer, several readings were recorded for each curve, and the average of the readings on any curve did not vary from the true figure for that curve by as much as one degree.

Costs.—The cost of the labor and materials for constructing this instrument at the North Carolina Highway Commission shops was slightly less than $100, of which the cost of materials was $18.13. Standard sizes and stock parts were used wherever possible. Since some of this labor was used in experimenting, it is estimated that a duplicate of this machine could be produced for about $85.

Performance.—In 1939, a 2-man party (one driver and one observer) made a special state-wide trip with the curvemeter car to survey hazards (excessive curvature, excessive grades, deficient superelevation, and restricted sight distances) on 275 miles of road, at a total field cost of $1.25 per mile (including salary, expense and use of car).

In 1940, this same party completed another state-wide survey of 945 miles at a total field cost of $1.10 per mile.

On these two special survey trips, a total surveyed mileage of 1,220 miles was covered at a total field cost of $1.13 per mile. Had the data been taken on both of these surveys at one trip, and dual travel eliminated, it is estimated that the work could have been done for about $1.00 per mile, or less. Some of the roads surveyed in the eastern part of the state had no excessive curves, while on some of the roads in the western mountainous section of the state, there were more than 20 excessive curves per mile. No trouble developed with the curvemeter on either of these surveys.

Possible Improvements.—Suggested improvements over this design would be to use a flat vertical dial scale, parallel to the dashboard, instead of a frustum of a cone, and to have one pair of bevel gears actuating the dial instead of the two pairs of spur gears used in this design.

Some experience and trial by a competent engineering observer is necessary to obtain the desirable accuracy.

MARYLAND HIGHWAYS MARKED WITH NEW REFLECTIVE SIGNS

A statewide installation of signs of the retro-directive reflection type has been made on the main highways of Maryland. A total of 1,970 symbols made of Lucite in the Stimsonized form have been erected. These have been placed at every point where there is a change in direction, a road intersection, or a railroad crossing.

The symbols are mounted on 24-in. square plates, and 12 basic designs were developed to cover all road conditions encountered in Maryland.

For simple right or left changes in the route, it was found that three degrees of directional indication were needed—the least for bends, a medium amount for curves, and the greatest amount for turns. These were expressed with large arrows arranged with the corresponding degree of curvature.

A simple "T" design served three functions, depending upon the position in which it was mounted. Upright, it indicated a "dead end" and, sidewise, it indicated right or left feeder roads.

Two "S" shaped symbols, for right or left, were designed to indicate reverse curves. A plain cross was utilized for intersections and a "Y" for forks in the routes.

Lettering was used only in the design chosen to indicate a railroad crossing. Here a cross with an extra lateral bar was employed in combination with two "R's." Plain diagrams were used for the other symbol plates in the belief that the greater the simplicity the more forcible and rapid would be the impression on the motorist's mind.

The signs were made by the Signal Service Corporation, Elizabeth, N. J., and were installed under the direction of Robert M. Reindollar, Assistant Chief Engineer, Maryland Road Commission.

A NEW COST DATA BOOK

Outline of Contents

CHAPTER 1. INTRODUCTION—Brief discussions of construction costs, prices, profits and the uses of cost data.
CHAPTER 2. COST INDEXES—Indexes of the U. S. Public Roads Administration and Interstate Commerce Commission, with brief explanations of their construction, uses and limitations.
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CHAPTER 4. ENGINEERING—Data from states, cities and other sources on the costs of various kinds of surveys and other engineering. There are brief articles on aerial surveys and seismographic soil and rock surveys.
CHAPTER 5. RIGHT-OF-WAY—A general discussion followed by records of actual experience and costs.
CHAPTER 6. EQUIPMENT—This chapter contains several rental and ownership expense schedules in full detail, followed by articles on operating and maintenance costs, including records of fuels, lubricants, etc., a mathematical analysis of the problems of selecting and retiring machines, and a table of depreciation rates.
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CHAPTER 8. CLEARING AND GRUBBING—Records of clearing with tractor-mounted equipment, hand and horse methods, stump blasting, etc.
CHAPTER 9. GRADING—Eighty-four pages of articles on grading with power shovels, scrapers of various types and sizes, elevators, blade graders, bulldozers, etc.; hydraulic grading; rock drilling and blasting; winter grading; special swamp grading; minor operations and hand work.
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CHAPTER 11. PRODUCTION OF AGGREGATES—Articles on labor requirements and costs of producing sand, gravel and crushed stone at various locations.
CHAPTER 12. UNTREATED BASES AND SURFACES—Waterbound macadam, crushed rock and gravel construction.
CHAPTER 13. STABILIZATION OF BASES AND SURFACES—This chapter is devoted chiefly to work with calcium chloride, articles on portland cement and bituminous stabilization being given in the chapters on concrete and bituminous construction.
CHAPTER 14. BITUMINOUS SURFACES AND BASES—The five parts of this long chapter contain articles on various methods in different states. Part 1, Surface Treatments; Part 2, Bituminous Macadam; Part 3, Mixed-in-Place Construction; Part 4, Traveling Plant Construction; Part 5, Stationary Plant Construction.
CHAPTER 15. CONCRETE SURFACES AND BASES—Contains numerous detailed records of construction. There are articles on work with 27-E pavers, 34-E pavers, tandem set-ups, batching, hauling, curing, joints, cement-bound macadam, soil-cement roads, stabilization, and other subjects.
CHAPTER 16. BRICK PAVEMENTS—Records of brick pavement construction from various cities and states, including an article on vibrated monolithic. Short references to granite block.
CHAPTER 17. SIDEWALKS, CURBS AND GUTTERS—Miscellaneous prices and details of construction.
CHAPTER 18. WALLS, FENCES AND GUARD RAILS—A brief chapter of data on these items of highway construction.
CHAPTER 19. BRIDGES AND CULVERTS—Cost data on a large number of steel, concrete and timber bridges and grade separations—also culverts of various types. There are two articles on pump installations for underpass drainage.
CHAPTER 20. TUNNEL CONSTRUCTION—Detailed descriptions and data on the construction of 27 highway tunnels in the West.
CHAPTER 21. GRASS, SHRUBS AND TREES—Several articles on plantings for landscape improvement and bank protection.
CHAPTER 22. MISCELLANEOUS—Data on pedestrian underpasses, street car loading platforms, truck weighing stations, catch basins and manholes, lignin binder, water pumping, signs and markers, traffic striping, parking meters, highway lighting, radio communication with snow plows, accident prevention, and weather and construction.
INDEX—Unusually complete: arranged for quick reference and maximum convenience.

Road and Street Construction Methods and Costs

BY

HALBERT P. GILLETTE

AND

JOHN C. BLACK

This book was planned and compiled expressly for use by contractors, engineers and highway officials.

It is not a textbook, but is a compendium of data carefully selected with reference to their usability by highway builders and other persons concerned with highway construction costs.

In general the data are of two main classes—dollar and cents costs per mile, per square yard, per cubic yard, and the like, for use in quick approximate estimates; and details of material, labor and equipment costs, with records of man-hours and machine-hours, for use in close estimating and in studies to reduce costs or improve methods.

The data are from a great number of different sources, and are in widely varying detail.

All major articles carry descriptions to show clearly the class of work and the methods for which costs are given, and to provide a basis for further reference and study if desired.

Location and date of job and the source of information are given in the title and introduction to each article.

The grouping of subjects in chapters is convenient, but an unusually complete index is furnished as the main guide to any subject or sub-subject sought.

The authors are both men of practical experience in highway and other construction. Both are members of the American Society of Civil Engineers.

The book is filled with useful data, and its answer to just one question may easily be worth hundreds of times its price.

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WHAT IS THIS PREFORMED WIRE ROPE?

By F. L. SPANGLER, M.E.

PREFORMED rope was developed in 1924. Prior thereto, all rope was non-preformed. But today every manufacturer of wire rope in the United States is making preformed rope as well as non-preformed.

In the manufacture of wire rope, the difference between preformed and non-preformed is a matter of how the strands are closed onto the hemp core or independent wire rope center. In making non-preformed rope, these strands, which may consist of anywhere from 3 to 37 wires each, are forcibly closed onto the center, and held in place by seizings at the ends of the rope. In making preformed rope, on the other hand, each strand is preshaped to the exact spiral it assumes in the finished rope. These spiral-shaped strands are then assembled onto the core. Whether these strands are straight to begin with and then forced into their final spiral shape, as in non-preformed rope, or are spiral-shaped at the start and then merely laid in their positions on the center, as in preformed rope, determines whether the rope will be rebellious and cranky, or be limp and easy to manage.

When wire strands are forced into their position, as in non-preformed rope, they tend to unlay, or unravel, in order to assume their original straightness. The forces introduced by the manufacturing operation are continually tugging away at the wires, but are held in check by the wires themselves and by the seizings at the ends of the rope. If a wire breaks, naturally the broken ends tend to straighten out, and they "porcupine," or stick out from the rope. Should the rope be cut, or a seizing removed, the ends of the strands and ropes fly out in all directions, and the rope unlays for 10 to 20 ft. or more, becoming a jumbled mass of wires.

The tendency of the wires in non-preformed rope to crowd outward causes them to bind or press against one another, and the friction between wires prevents them from adjusting themselves fully to a loaded condition, whether it be an axial load such as produced by a weight at the end of the rope, or a bending stress introduced by flexing over a sheave or drum. These internal forces also tend to make the rope twist and squirm when an axial load is applied.

But in preformed rope, the strands and wires lie dormant. There are no locked-up stresses introduced by the manufacturing operation. There is no binding between the wires, and when a load is applied the strands merely close in and seat more firmly on the rope center, with little or no, tendency to squirm or twist. When the rope bends over a sheave or drum, the only stresses are the axial stresses caused by the tension in the rope, and the bending stresses. The wires have more freedom to adjust themselves to load conditions. Hence, the load is more equitably distributed between the wires, and the total stresses in the wires are somewhat lower than in non-preformed rope. The broken ends of crown wires continue to lie in their place, and do not change from their original formation except to separate slightly, allowing them to be detected at close range. When not seized, the ends of the rope do not fly out and unravel.

All of this has an important bearing on the service ropes will give. Where the wires bind and develop friction, as in non-preformed rope, the wires cannot act with the freedom they have in preformed rope, where the absence of locked-up stresses eliminates almost all evidence of binding and friction. Hence, preformed rope shows a greater flexibility than non-preformed rope, it runs truer and straighter, adjusts itself more easily to the curvature of the sheave or drum, has practically no tendency to loop into a kink, and resists rotating in sheave grooves.

Many ropes are permanently damaged by kinks, formed by pulling the rope tight after it has been thrown into a loop. Kinked ropes are dangerous and should never be used.

The absence of locked-up stresses in the wires of preformed rope, and the ease with which this rope adjusts itself to equalize the load between wires, result in comparatively low unit stresses in the wires of preformed rope. Since the magnitude of the stress is an important factor in fatigue, preformed rope shows greater resistance to fatigue than does non-preformed rope.

Fatigue results in breaks or fractures in the wires, usually showing up first in the outermost, or crown, wires. Where ropes operate over sheaves and drums, especially if of small diameter, fatigue is frequently the determining factor in the life of the rope.

When a wire is grasped between the forefinger and thumb of both hands and bent back and forth, a fatigue break soon develops. Similarly, when a rope passes onto and off a sheave or drum, it meets the same bending action and in time fatigue breaks develop in the rope wires. The greater the change in stress in the wire, and the more frequently these stress changes occur, the sooner fatigue starts its destructive action.

Fatigue is accelerated by whipping or vibration, since this produces rapid changes of stress in the wires of the rope, and causes stress concentration at the end of the rope where it is attached to a socket, clip fastening, or other attachment. Fatigue often makes its first appearance at these points, and is further accelerated if the attachment has been improperly made. For example, a change in the direction of rope lay where the rope enters the socket, even if only slight, increases greatly the stress at this point.

Preformed rope is less subject to vibration, and its resistance to fatigue makes it desirable where conditions tend to promote fatigue at sockets or other attachments. Vibrations are quickly dampened by preformed rope, because of the ability of the wires to adjust themselves and absorb the energy of vibration. Non-preformed rope, being less flexible, does not absorb vibrations so readily. Where operating conditions promote whipping and vibration, preformed rope can be expected to give longer service than non-preformed rope. Moreover, the fact that the strands and wires in preformed rope retain their positions and do not unlay makes socketing easier, with less likelihood of disturbing the direction of lay of the rope, hence promoting a better socketing condition and adding to the life of the rope.

Though preformed rope's greatest asset is its resistance to fatigue, there are installations where preformed rope

is used because of safety considerations. For the many applications where the rope must be handled with hands, the fact that broken crown wires in preformed rope refuse to "porcupine" reduces the likelihood of skin lacerations and infections. Hand injuries are frequent where men must handle non-preformed ropes with broken wire ends sticking out from the rope. These projecting wire ends also contribute to the deterioration of non-preformed rope by being bent over or clinched onto adjacent wires by sheaves and drums. Thus other wires aer niched or shoved out of place, producing a condition that invites fatigue. Where fatigue causes wire breaks in the rope, preformed rope is acknowledgely easier and safer to handle.

In the case of standing ropes, such as guys, spars, and cables for suspension bridges, fatigue of the rope is not a factor. Here the non-preformed rope is fully satisfactory. Much the same is true for boom lines on cranes and wherever the rope is infrequently operated over sheaves.

Preformed rope plays its major role in the types of installations requiring frequent operation over sheaves, and it is in such applications that its field of use is rapidly expanding.

JUNIOR ENGINEERS WANTED FOR GOVERNMENT SERVICE

In connection with the National Defense Program, the United States Civil Service Commission has announced an open competitive examination to secure junior engineers for Government service. The examinations cover all branches of engineering except aeronautical, naval architecture and marine engineering. The salary of $2,000 a year is subject to a retirement deduction of 3½ percent.

Applications must be in the Commission's Washington office not later than Oct. 24 if received from states east of Colorado, and Oct. 28, 1940, if received from Colorado and states westward.

Applicants must have completed a 4-year engineering course at a recognized college. They will be rated on a written examination consisting of general and professional questions. The maximum age limit is 35 years, unless applicants are granted veteran preference.

Full information as to requirements for the examination, and application forms, may be obtained from the Secretary of the Board of U. S. Civil Service Examiners at any first- or second-class post office, or from the United States Civil Service Commission, Washington, D. C.

U. S. Has 68.5 Per Cent of Motor Vehicles

According to statistics in the *Automotive World News*, a publication of the U. S. Bureau of Foreign and Domestic Commerce, the United States ranks first as a user of motor vehicles with 31,009,870 units in continental United States and 94,248 in the non-contiguous territories (Alaska, Hawaii, Puerto Rico and Virgin Islands), making a total of 31,104,118 units, 68.5 per cent of the world total. In second position as a user of motor transportation is the United Kingdom with 2,429,580 motor vehicles, followed closely by France with 2,398,500 units. Germany ranked fourth with registrations on January 1, 1940 of 1,959,200 units and Canada fifth with 1,420,924 units. The next principal users in order of their importance are as follows: Australia with 837,164; U. S. S. R., 801,000; Italy, 498,500; and Union of South Africa, 370,641.

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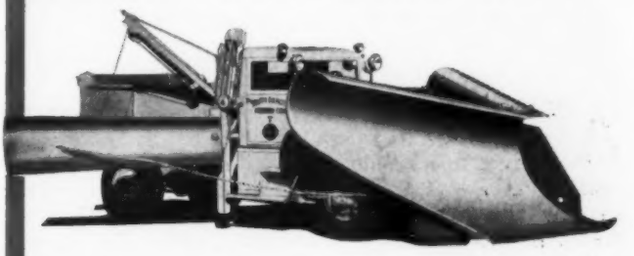

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How To Determine Economic Project Size

By Statistical Analysis Lowest Average Unit Costs Are Determined

By JOHN M. DOYLE
State Highway Planning Survey of North Dakota

ANALYZING construction project costs over the period 1935 to 1938, inclusive, North Dakota has arrived at a result which indicates that there is an economical size of project for minimum total cost to the state. At the outset it must be clearly borne in mind that the total cost includes preliminary, office design, and field engineering costs, as well as the contract costs of the project. However, costs of major structures, those over 20 ft. span, are not included, nor are general highway department administrative costs included.

In this short article an effort is made to outline the procedure employed in order to give an understanding of the basic concepts, without attempting to explain mathematical calculations and derivations or reasons for adopting certain mathematical procedures. For a more complete understanding of these phases reference can be made to the North Dakota State Highway Department.

It is believed that the analyses made by North Dakota are applicable in principle to other states but the results and basic data are different.

General Procedure

What it is desired to determine is the most economical size of construction project such that it will be the least total cost to the Department of Highways.

The basic data employed are the following:

(1) About 40 projects.
(2) Contract costs exclusive of major drainage structures, i.e., those over 20 ft. span.
(3) Field and office engineering costs on each job; preliminary survey costs, design costs, field engineering construction costs.
(4) Total cubic yards of excavation.
(5) Total contract costs to include incidental constructions, guard rail, etc.
(6) Length in miles of each project.
(7) Graded roadbed widths.
(8) Type of contract to show special labor provisions, like FAP, WPH, NRH, etc.
(9) Year contract was awarded.

The divergent groups of cost information are reduced

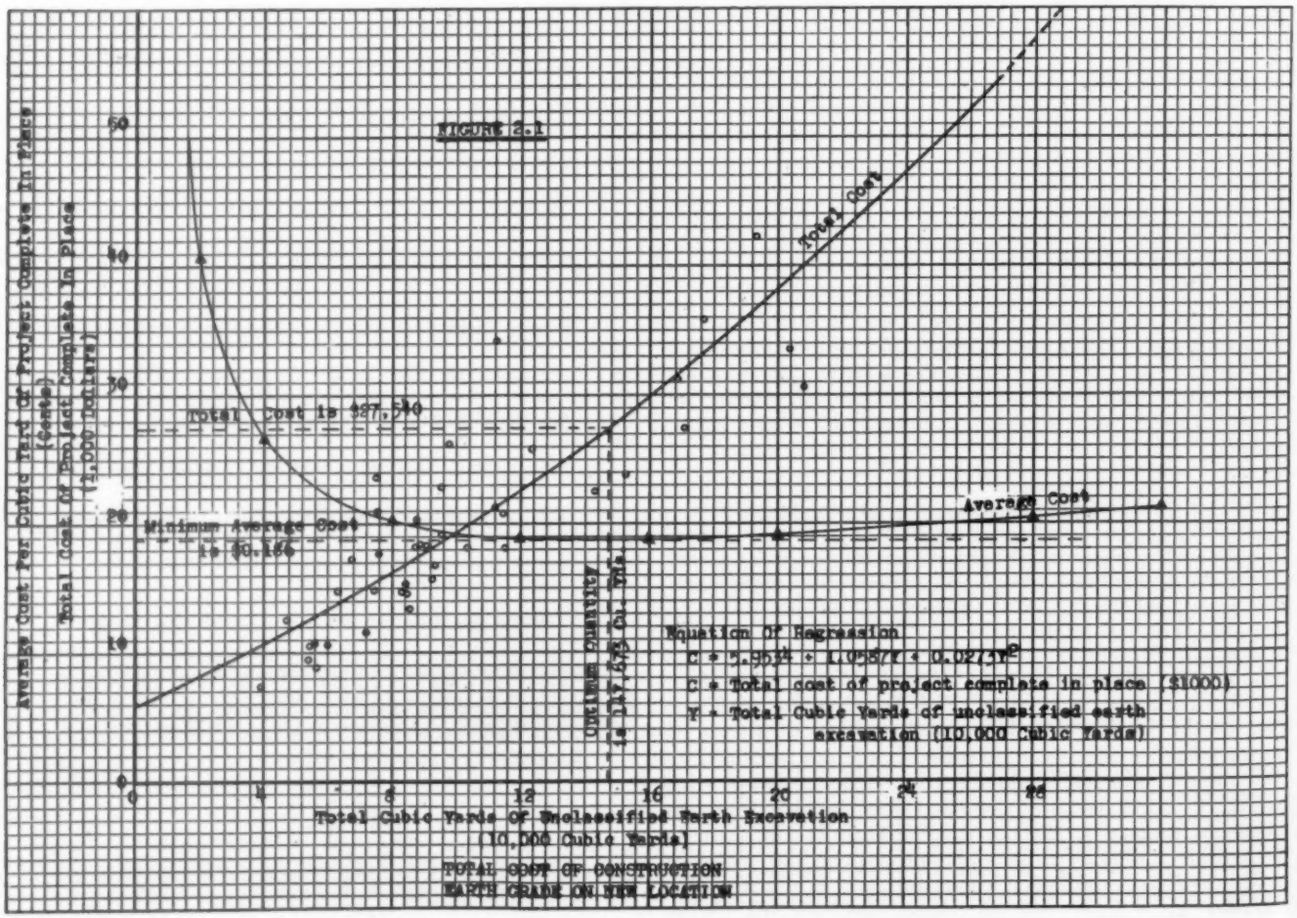
FIGURE 2.1
Average Cost Per Cubic Yard Of Project Complete In Place (Cents)
Total Cost Of Project Complete In Place ($1,000 Dollars)
Total Cost
Total cost is $27,540
Minimum Average Cost is $0.166
Average Cost
Equation Of Regression
C = 5.953Y + 1.058Y + 0.027Y²
C = Total cost of project complete in place ($1000)
Y = Total Cubic Yards of unclassified earth excavation (10,000 Cubic Yards)
Total Cubic Yards Of Unclassified Earth Excavation
(10,000 Cubic Yards)
TOTAL COST OF CONSTRUCTION
EARTH GRADE ON NEW LOCATION

Fig. 1

GROUND JOINT ..WASHERLESS

Compact Type, Style XLD-41. ½" and ¾"

Heavy Type, Style XHD-52, ¾" and 1"

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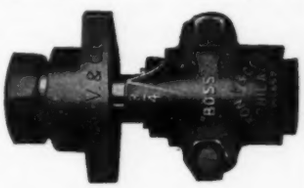
GROUND JOINT... WASHERLESS



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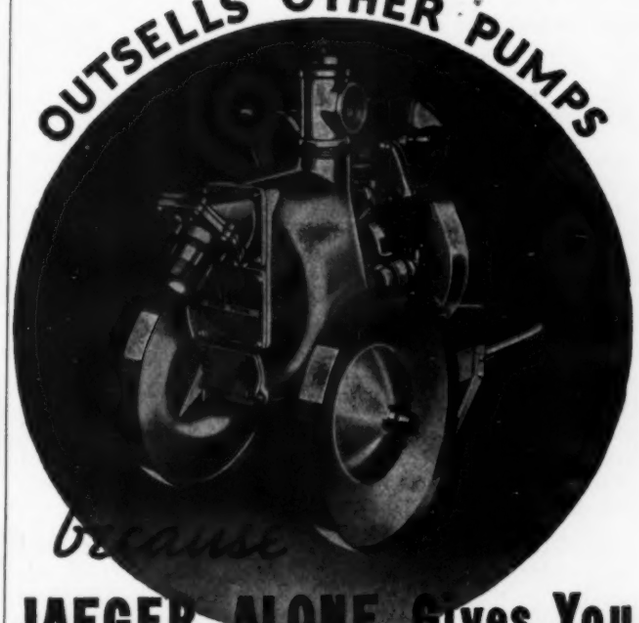

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to a mutually comparable basis by means of an appropriate index. The formula used is:

$$I = \sqrt{\frac{\Sigma P_1Q_0}{\Sigma P_0Q_0} \times \frac{\Sigma P_1Q_1}{\Sigma P_0Q_1}}, \text{ where}$$

P_0 = price current during base interval.
P_1 = price current during given interval.
Q_0 = Quantity current during base interval.
Q_1 = Quantity current during given interval.

Discussion of this formula may be obtained from "The Making of Index Numbers" by Irving Fisher, and "Economic Statistics" by Crum, Patton, and Tibbutt. Thus is formed a type-time index, developed from the items which contribute to variation of cost. The application of the indexes to the observed costs then reduced the amount of variation to that which would be expected from regression (i.e., from the mean for each value of yardage). A base year is selected for reference and comparison.

Next the total cubic yards of excavation are plotted on standard cross-section paper against the total adjusted cost of each project. These are shown by Fig. 1 as small circles.

A curve is then fitted to these points by the selection of a linear, a second degree, or a third degree equation curve. Each degree curve is calculated for fitness by the method of least squares and that one selected in which the summation of the squares of the deviation of the individual points is the least.

In Fig. 1, the total cost curve is a second degree curve and best fits the original adjusted data. Next, the total cost at definite yardages is picked off of this curve. The cost reduced to cost per cubic yard and a second series of points plotted. These are shown as triangles on Fig. 1. Through these average cost per cubic yard points a smooth curve is drawn which will be the curve of average unit cost for all of the projects. The total cost curve is referred to as the regression equation curve. North Dakota has adopted the following equation for total cost:

$$C = 5.9534 + 1.0587Y + 0.0273Y,^2 \text{ from which}$$

$$\text{Average cost} = \frac{C}{Y} = \frac{5.9534}{Y} + 1.0587 + 0.0273Y.$$

In these equations C, the total cost, is expressed in $1,000 units and Y is expressed in 10,000 cubic yard units.

This equation is obtained empirically by employing the methods of multiple regression of one variable with respect to another variable after the example given in Chapter 13 of "Statistical Methods" by George W. Snedecor.

Some interesting conclusions can be drawn from these curves.

(1) The average cost per cubic yard of earth excavation for small projects is prohibitive.
(2) As the quantity of excavation yardage increases to 147,673, the average cost drops very rapidly to a minimum value.
(3) The average cost increases only slightly after the minimum point is passed.
(4) The most economical size of contract will fall along the lowest, most nearly horizontal part of the average unit cost curve.
(5) By passing a vertical line through the point of tangency of a horizontal line with the average cost curve up to an intersection with the total cost curve, it is possible to determine the most economical total cost of the project complete.

From data available as to mileage lengths, this economical yardage or total cost can be converted into mileage of project. In the case shown here, the economical project length is roughly seven miles.

THIS CONTRACTOR HAS NO LABOR TROUBLES

One contractor, at least, has no labor troubles. He is Fred Brooks. He operates in Northeastern Missouri, mostly doing small road jobs, or building water and conservation dams. His crew consists of his two sons, a daughter and a nephew. His wife takes care of the comforts of the family, doing the cooking when necessary, and handling the miscellaneous essential home making jobs. Most of the time the family lives in trailer houses, which are nicely furnished and very homelike.

One Contractor's Family: Left to Right—Rex and Archie, Sons; Freddie Brooks, Nephew; Neta Bess Brooks, Daughter; Mr. Brooks, and Mrs. Brooks

With his whole family on the job (and very satisfied indeed with the work they do) Mr. Brooks has not had to have an outsider on the payroll for several months.

On a recent road job on Highway 4 between Kahoka and Wayland, Mo., Mr. Brook's equipment consisted of two LaPlant-Choate rear dump scrapers; two Caterpillar diesel D7 tractors; one Caterpillar diesel Forty Tractor, teamed with a LaPlant tamper, one Caterpillar motor grader, and a Sixty Six blade grader. The two sons, Rex and Archie, operated the scrapers, the motor grader and the blade grader. The nephew, Freddie Brooks, pitched in on these jobs, also. Miss Neta Bess Brooks, the daughter, operated the diesel Forty tractor and the tamper.

All the children attend school during the winter and all expect to go to college. As a result of their summer activities, each of them has a bank account, and this is sufficient to finance them through their entire educational training.

51 Accidents Per Day on Indiana Highways—An average of only 51 accidents per day on the 10,000 miles of Indiana state highways, including state maintained routes through cities and towns, was recorded during July and August when traffic volume is at a peak. Approximately one-third occurred on the 400 miles of highway routes maintained through cities of over 3,500 population.

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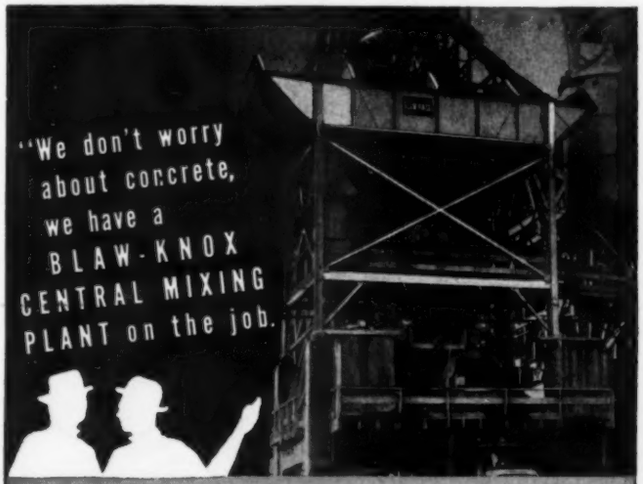

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LABORATORY TESTING TERMS

A Glossary of Material Testing Terms and Methods of Test

By D. G. RUNNER,* Mem. A.S.T.M.
Washington, D. C.

AS FAR as is known, there is no glossary of terms pertaining to laboratory testing. Definitions covering this field are widespread in various publications of The American Society for Testing Materials, of The American Association of State Highway Officials, in handbooks, and in other miscellaneous sources. It is believed that a concentration of definitions of words, phrases, methods of test, equipment and apparatus used in laboratory testing would have a place in the literature to supply a compilation for ready reference.

The words used in this glossary pertain mostly to the more commonly used equipment and apparatus used in non-bituminous testing. There are, however, some terms which apply to bituminous and soil testing fields. Obviously the following glossary is not complete, for the number of such words in the field must run into hundreds. No originality is claimed for the majority of the terms used herein, as most of them have been selected from the literature.

A. A. S. H. O.—The American Association of State Highway Officials, National Press Bldg., Washington, D. C.

Abrasive Charge—In the Deval test for gravel, the charge consists of six cast-iron balls, 1.875 in. in diameter and weighing about 0.95 lb. each. The charge for the Los Angeles abrasion machine consists of cast-iron or steel balls about 1⅞ in. in diameter and weighing between 390 and 445 grams each. Grading "A" in this test calls for 12 balls weighing 5000 grams ± 25 grams, and grading "B" calls for 11 balls weighing 4583 grams ± 25 grams. The abrasive charge for the brick rattler consists of ten cast-iron balls 3.75 in. in diameter and weighing 7.5 lb. each, and between 245 and 260 small cast-iron balls 1.875 in. in diameter and weighing about 0.95 lb. each.

Absolute Humidity—Refers to the actual density of water vapor in the air, expressed in grains per cubic foot.

Absolute Weight—The weight of a unit volume of a material, if all the voids were actually filled by the material itself.

Absorption Test of Aggregates — This test is made by measuring the amount of water absorbed by the test sample in a definite length of time, usually 24 hours. The result is commonly expressed as a percentage of the oven-dry weight of the sample.

Accelerated Soundness Test — Usually refers to sodium or magnesium sulphate soundness tests, or to freezing and thawing tests made on fine and coarse aggregate.

Aggregate—The mineral material such as sand, gravel, shells, slag, or broken stone, or combinations thereof with which the cement or bituminous material is mixed to form a mortar or concrete.

Aggregate (In Soils)—Sometimes refers to material retained on the number 10 sieve.

Alpha Dicalcium Silicate—A modification of the portland cement compound dicalcium silicate, probably stable only at high temperatures.

Angular Fragments—A term referring to particles of aggregate having flat faces, sharp edges, and corners.

Anhydrous (Salt)—As used in the accelerated soundness test, this term refers to Na_2SO_4 and $MgSO_4$ for sodium and magnesium sulphate respectively.

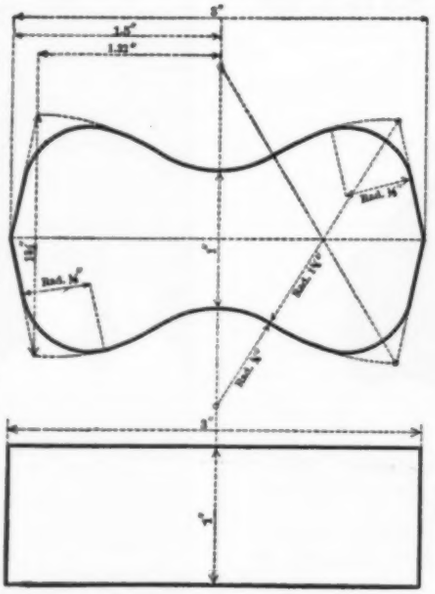

Fig. 1—Details of Briquet Specimen

A. S. T. M.—The American Society for Testing Materials, 260 South Broad St., Philadelphia, Penn.

Beta Dicalcium Silicate—An important compound of portland cement and the one chiefly responsible for the development of strength at late ages. Commonly abbreviated to C_2S.

Bin—As used in laboratory work, a storage receptacle for sand, gravel, stone, etc.

Bituminous Emulsion—A liquid mixture in which minute particles of bitumen are held in suspension in water or a watery solution.

Blast Furnace Slag—The non-metallic product consisting essentially of silicates and alumino-silicates of lime, which is developed simultaneously with iron in a blast furnace.

Breaking of Emulsion—The process of the separation of the bitumen from other constituents in a bituminous emulsion.

Briquet—A cement or sand test specimen having a cross-section of 1 in. (Fig. 1.)

Bulking—The increase in volume in fine material such as sand, resulting from the presence of moisture, or an excess of voids due to lack of compaction.

Calcium Hydroxide — A compound formed by the hydration of free lime or on hydrolysis of the portland cement compound C_3S. The formula is $Ca(OH)_2$.

Calcium Sulphate — The usual retarder used to control the set of portland cement. This usually is in the form of gypsum, $CaSO_4.2H_2O$ but occasionally is added as plaster $CaSO_4.\frac{1}{2}H_2O$ or anhydrite $CaSO_4$.

Calcium Sulphoaluminate — A portland cement compound formed by the interaction of calcium sulphate and alumina compounds in solution. The continued formation of this compound due to the action of sulphate waters on cement may give rise to disintegration.

Calorimeter—An instrument for measuring heat of solution, of portland cement.

Cementing Value Test—To determine the binding power, or cementing value.

* Author Geology for Civil Engineers; Co-author with V. J. Brown of Engineering Terminology.

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as it is usually called, 500 grams (1.1 lb.) of the material to be tested is crushed to pea size and ground with water in a ball mill until it has the consistency of a stiff dough. It is then molded into cylindrical briquets 25 x 25 mm. in size, which after thorough drying, are tested to destruction in a special form of impact machine. A 1-kilogram (2.2 lb.) hammer falls through a constant height of 1 centimeter (0.39 in.) upon an intervening plunger, which in turn rests upon the test piece. The number of blows producing failure is called the cementing value of the material.

Clay—A natural substance or soft rock which, when finely ground and mixed with water, forms a pasty moldable mass that preserves its shape when air dried: the particles soften and coalesce upon being highly heated and form a stony mass upon cooling. Clays differ greatly mineralogically and chemically and consequently in their physical properties. Most of them contain many impurities, but ordinarily their base is hydrous aluminum silicate.

Clinker—The sintered product obtained in the manufacture of portland cement, which, when pulverized with the addition of calcium sulphate produces portland cement.

Coal—A carbonaceous substance formed from the remains of vegetation by partial decomposition.

Coarse Aggregate—Fragmental material which will not pass a number 4 sieve.

Coarse Sand (In Soils)—That material passing a number 10 sieve and retained on a number 60 sieve.

Concrete (Portland Cement)—A mixture of portland cement, mineral aggregates and water, hardened by hydraulic chemical reaction.

Crushed Rock—The product resulting from the artificial crushing of ledge rock, boulders or large cobblestone substantially all faces of which have resulted from the crushing operation.

Cubic-Foot Container — A cylindrical measure of 1 cu. ft. capacity, used in obtaining the unit weight of aggregates. The dimensions are as follows:
Inside diameter .....14.00 in.
Inside height .....11.23 in.

Cut-back Products — Petroleum or tar residuums which have been fluxed with distillates.

Cycle—In the accelerated soundness test for aggregates a complete cycle consists of one immersion or soaking period and one drying period.

Decantation Test—A test method for fine and coarse aggregate in which the material is covered with water, agitated briskly, allowed to stand, and the water poured over a number 200 sieve. This is continued until the wash water is clear. Then the aggregate is oven dried and knowing the original weight, the percentage loss is calculated.

Delimeter — An apparatus, operated on dry cell batteries, used to determine the applied load when molding briquets.

Deval Abrasion Machine—The machine consists essentially of a hollow iron cylinder, closed at one end and fitted with a tightly fitting iron cover at the other. The cylinder is 20 cm. in diameter and 34 cm. in depth inside. The cylinder is mounted on a shaft at an angle of 30 degrees with the axis of rotation of the shaft.

Diamond Core Drill—A drill, usually power driven, used in obtaining a core from ledge rock for testing purposes. The crown of the drill is set with bortz and drills specimens 1 in. in diameter for the toughness test or 2 in. in diameter for the compression test.

Dicalcium Ferrite—An iron compound in portland cement which may be formed in the presence of an excess of Fe_2O_3.

Dolomite—A magnesian limestone composed essentially of the mineral dolomite, a double carbonate of calcium and magnesium. It is theoretically composed of 54 per cent calcium carbonate and 46 per cent magnesium carbonate.

Dorry Hardness Test (Of Rock)—Hardness is determined by subjecting a cylindrical rock core 25 mm. in diameter, drilled from the specimen to be examined, to the abrasive action of quartz sand fed upon a revolving steel disk. The end of the specimen is worn away in inverse ratio to its hardness and the amount of loss is expressed in the form of a coefficient as follows: Coefficient of harness = 20 — 1/3 W, where W equals the loss in weight after 1,000 revolutions of the disk.

Dry Bulb Temperature—Temperature of the air as indicated by a standard thermometer.

Dry Loose—A term used in describing the unit weight of aggregate. In this case the aggregate is placed in a cubic-foot container until overflowing, then the top is struck off level. The aggregate is not tamped in any way.

Dry Rodded—A term used in describing the unit weight of aggregate. In this case the aggregate is placed in a cubic-foot container in three layers, with each layer being tamped 25 times with a metal tamping rod.

Ductility (Of Bituminous Materials)—Is commonly measured by the distance to which it will elongate before breaking when two ends of a briquet of the material are pulled apart at a specified speed and at a specified temperature.

Elutriation Test—A determination of the total quantity of silt, loam, clay, etc., finer than the number 200 mesh sieve, in sand and other fine aggregates. The test is usually made by washing the sample over a number 200 sieve, and drying the residue. The percentage of silt, loam, and clay equals:

$$\frac{\text{Original dry weight} - \text{Weight after washing}}{\text{Original dry weight}} \times 100$$

Emulsion—A combination of water and an oily material made miscible with water through the action of saponifying or other agents.

Fat—Sometimes containing an excess, as of binder such as bitumen.

Fine Aggregate—See sand.

Fine Sand (In Soils)—That material passing a number 60 sieve and retained on a number 270 sieve.

Fineness Modulus—In the case of aggregates for concrete, an empirical factor obtained by adding the total percentages of a sample of the aggregate retained on each of a specified series of sieves, and dividing the sum by 100. The sieves are: Nos. 100, 50, 30, 16, 8, 4, 3/8 in., 3/4 in. and 1½ in.

Fineness Test of Cement—This test is made by sieving a definite amount of cement through a number 200 sieve until less than 0.1 per cent of the original weight of the sample passes through the sieve when shaken in a stipulated maner for one minute. At this joint the residue is weighed and expressed as a percentage of the original weight. (See Turbidimeter.)

Flash Point — The flash point of an asphaltic product is the temperature at which, during heating, its evolved vapors will temporarily ignite or flash, when a small flame is brought in contact with them.

Flash Set (Of Cement) — A cement which sets very rapidly after the addition of water.

Flour (In Cement) — The impalpably fine portion of portland cement.

Flow Table—A laboratory apparatus for determining the consistency of mortar or concrete. It consists essentially of a circular bronze plate of a definite diameter, so mounted that the surface is level, and equipped with a mechanism for raising the plate a given height and allowing it to fall without cushioning. A bronze cone of a definite height and diameter rests on top of the table, and is filled with mortar or concrete.

Flux Oil—Oils used for the purpose of softening bituminous materials.

Fluxes—Bituminous materials generally liquid, in which the predominating constituent is bitumen, used in combination with asphalts for the purpose of softening the latter.

Free Lime—Calcium oxide (CaO) which remains uncombined in portland cement clinker due either to excess lime in the mixture or to underburning. Occasionally the term is used to apply to calcium hydroxide formed when water is added to portland cement, but this use should be iscouraged.

French Coefficient of Wear—A figure indicative of the abrasion loss of rock in the Deval abrasion machine. It is obtained by dividing 40 by the percentage of wear.

F. S. E. C.—Federal Specification Executive Committee.

(To be concluded in the November Issue)

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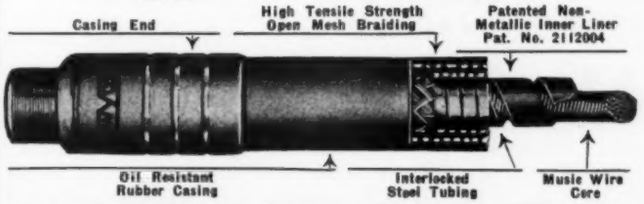
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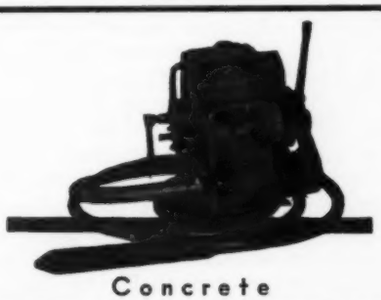

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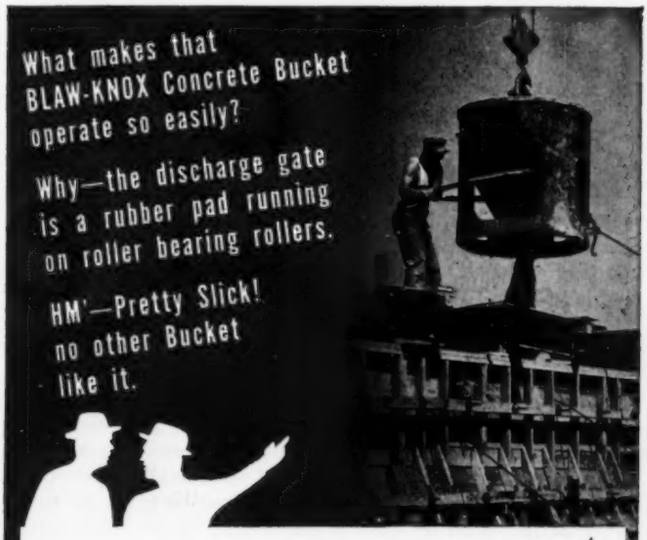
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EDITORIAL

FOREWARNED IS FOREARMED

MR CONTRACTOR, you have trouble keeping up with the new tax laws enacted by the Federal government and how they affect you. You often say, "What the ———, let George do it," when some legal or tax problem is brought to your attention. You sit by, maybe not so complacently, but nevertheless you sit, and let some one of your friendly competitors tie into a legal or tax case. Then you act in accordance with the decision handed down in the case. When you find that you've been subject to a tax and haven't paid it then you begin to worry about the delinquency and how best to conform. Often it costs you considerably more in the end than it would have had you known what you were up against at the start.

Well sir, you will have a chance next January to learn of some of the legal problems and tax troubles that confront you in new legislation.

Not only that, but by attending a meeting where this thing is going to be explained, you will also be able to learn about how to cut down on your compensation payments and something about some short cuts in social security accounting. This meeting will mean as much to you in dollars and cents saved as the putting of some new unit of equipment on your job. How do I know? I am one of the men that's arranging this meeting particularly for highway contractors. Other engineering contractors are welcome but I want the highway contractors to know that the subjects to be discussed and the questions they ask of the panel of lawyers and certified public accountants are those which vitally affect them as business men.

That's all I want to say at this time. Plan on attending this important meeting. I'll give you more dope in these pages next month.

EXTRA HIGHWAY DEFENSE FUNDS NEEDED

PROBABLY the most important result of the recent annual meeting of the American Association of State Highway Officials was the discussion on the use of regular federal aid for widening shoulders on those highways deemed necessary in the national defense. To the credit of the state highway engineers it should be noted that they opposed the plan which would upset normal peace time pursuits in road building. At the meeting it was the consensus of opinion that necessary shoulder widening for national defense purposes should be accomplished by extra emergency funds specifically appropriated from defense authorizations. Coordination of new construction with defense plans, so far as possible without upsetting normal peace time development, can be obtained and will be studied. Most any highway may become a necessary military route in case of defense, depending upon the theatre of action, so that construction of obsolete roads is just as important as widening on those roads designated in the Pershing plan.

Authoritative sources stated that Sec. 19 of the Federal Highway Act of 1940, permitted the Commissioner of Public Roads to give priority to projects that are recommended by the appropriate Federal defense agency as important to the national defense. Shoulder widening of the system of priority roads established by the War Department was construed to be a type of highway defense work that would fall in this category. Discussion indicated this work to be a misinterpretation of Sec. 19. State highway engineers are opposed to the plan, preferring to keep regular federal aid directed on new road construction work as long established policy has dictated. This was a sensible point of view. Shoulder widening of the Pershing plan roads should be accomplished with additional defense funds.

CREDIT IS DUE

WHEN a new improvement or changed style is built into an automobile the whole population talks about it, appraises it, and invariably is left with a most favorable impression of the development. Why? Because the automotive industry advertises and publicizes their developments far and wide. Even a 10 year old boy can effectively point out the difference between the 1920 product and the 1940 product.

How many engineers and contractors can point out the improvements and developments in the lowly bag of portland cement that have occurred over a span of the last twenty years? We take a bag of cement on faith with little or no knowledge of the improvements that have been manufactured into the quality of the contents of the bag.

Much has been said and printed about the increased quality of concrete but next to nothing about the increased quality of cement. Some very substantial improvements have been made in both over the past score of years. With those concerning concrete such as, application of water-cement ratio, more careful curing, ample mixing, and vibration, we are already familiar. In regard to cement, it may be noted that there has been a progressive improvement in its quality such that, with all other factors the same — same water-cement ratio, same temperature, same mixing—the strength of concrete made with standard cement as of today is practically double that as of 1920. To provide this has involved refinements in manufacture in a variety of ways. It should also be noted that despite the increase in cost of production and the increase in quality, the price realized has declined more than 10 per cent.

Many of the improvements made in the quality of cement has been a result of the specification written by the consumer. The contents of the cement bag is not an "untouchable" product as so many engineers and contractors seem to think. We now have at least five grades or kinds of portland cement as a result of specification requirements. At this writing the cement companies as well as the research departments of other agencies are busy searching for the answer to scaling of concrete pavements. Long strides have been made. Admixtures have been and are being studied that seem to offer a solution. The time is not yet arrived, however, to make definite recommendations to the cement manufacturer as to how and what to do about these admixtures.

With regard to advancements already made more publicity should be given to the specifier and buyer of cement. They should be thoroughly acquainted with the various grades now manufactured and the purpose for which each grade may be used. Publicizing is the responsibility of the manufacturer. This job, one might say, has not been done at all. When improved products are made, cement manufacturers could take a leaf from the note book of the automotive industry, and tell the world about their improvements.

NEW BOOKS

ENGINEERING TERMINOLOGY

Definitions of Technical Words and Phrases

Second Edition

By V. J. Brown
Publishing Director, ROADS AND STREETS
and
D. G. Runner
Assistant Materials Engineer,
U. S. Public Roads Administration

A word or phrase in one branch of engineering may have an entirely different meaning in some other branch. Various branches of applied engineering, all of which spring from the common root of natural and physical science, have found it expedient to develop a specialized vocabulary. This book is a step toward avoiding misunderstanding and difficulty from this cause for purposes of contracts, correspondence, agreements, price lists, specifications, etc., between the different branches of engineering, the public, and other professions. It is arranged in dictionary form. The book fills a need or want in engineering literature. It also initiates the standardization of engineering terms. Valuable appendices include English-Spanish terms; Spanish-English words; German-English aggregate terms; Symbols for Hydraulics; Standard Pump Classifications; Materials for Pumping Various Liquids; Abbreviations for Scientific and Engineering Terms; Symbols for Mechanics, Structural Engineering and Testing Materials; Weights and Measures; Conversion Factors.

439 pages—Dark red buckram binding.

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SOIL STABILIZATION

By V. J. Brown
Publishing Director, ROADS AND STREETS
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U. S. Public Roads Administration
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Research Engineer,
George Washington University
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Texas State Highway Department
C. M. Lancaster
Soils Engineer,
Missouri State Highway Department
E. S. Barber
Junior Highway Engineer,
U. S. Public Roads Administration

This book is reprinted from a series of articles published in ROADS AND STREETS. Demand for the series was world wide. The book treats of fundamentals of soils mechanics and soil stabilization such that the average engineer can get a complete understanding of this new branch of highway engineering.

It is the best treatise on the subject so far published, and is a vital need for the engineer who is considering low cost road improvement or grading embankment control.

Profuse illustrations tell more than words could.

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GEOLOGY FOR CIVIL ENGINEERS

As Related to Highway Engineering

By Delmar G. Runner
Assistant Materials Engineer,
U. S. Public Roads Administration

Rock and soils, and their characteristics, both physical and chemical, as well as their classifications and geographical distributions are discussed in such a way as to make this book particularly valuable for civil engineers and for engineering colleges. The chapters on material surveys, together with those on the petrographic microscope and its use constitute a real contribution to the fund of knowledge on engineering geology. This is the first time that the theories of general geology have been correlated by a competent engineer and geologist with the requirements of highway engineering. The book is written from the engineer's viewpoint for engineers. It puts into usable, understandable language the facts concerning rock formations and gravel deposits hardness or toughness values, how to recognize suitable or undesirable materials, and the source or origin of rock types. It is particularly useful to those engineers charged with the responsibility of materials selection for construction or maintenance work.

CONTENTS

Introduction; Value of Engineering Geology; Road Material Survey Methods; Relation of Geological Formations to Material Surveys; The Common Rock Making Minerals; Igneous Rocks; Metamorphic Rocks; Sedimentary Rocks; Origin and Roadbuilding Properties of Shale; Origin and Roadbuilding Properties of Caliche; Origin and Roadbuilding Properties of Limerock; Origin and Composition of Clays; Preparation and Properties of Blast Furnace Slag; Low Cost Road Surfaces; Petrography and the Quality of Rock; Sand and Gravel Deposits; Soils and Soil Tests; Glossary of Geological Terms; Glossary of Highway Terms; Names and Addresses of Highway Departments; States With Geological Commissions; Testing Material Procedures.

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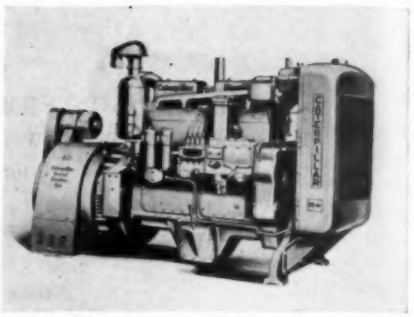
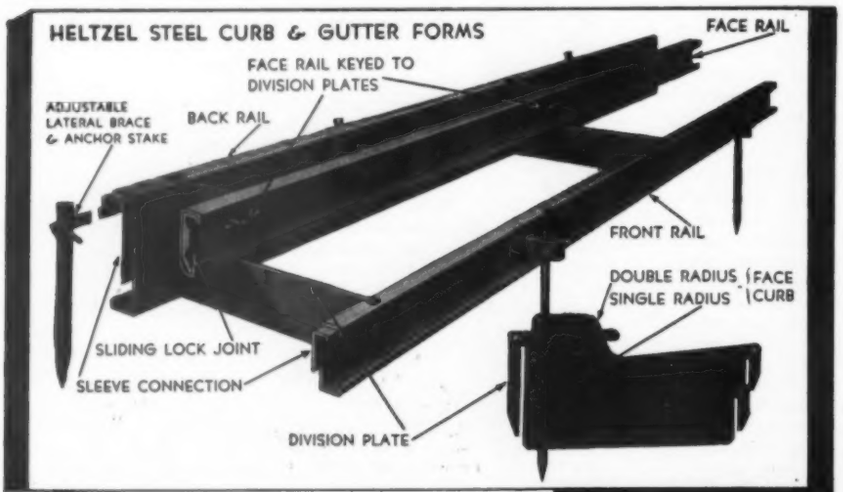
NEW EQUIPMENT and MATERIALS

New Diesel Electric Sets

Two new diesel electric sets have been added to the line of the Caterpillar Tractor Co., Peoria, Ill., thus giving the company a complete in electric set sizes from 15 to 85 kilowatts. The new models, the 88-41 and the 77-34 are 34 and 41 kilowatt units. Both units are powered by 4-cylinder diesel engines. The 88-41, with a bore of 5¾ in. and an 8 in. stroke, develops 41 WK at 900 RPM, when equipped with radiator fan. Without fan, kilowatt rating is 44. The 77-34 has a bore and stroke of 5¼ in. x 8 in., and develops 34 KW at the same RPM when equipped with fan. It is rated at 36 kilowatts without fan. Both ratings are for the polyphase, 60-cycle set. Single phase ratings are slightly lower. The sets are completely self-controlled, requiring no gadgets other than a circuit breaker. They are easy to install, and can be set up and running in less than an hour after delivery. Inbuilt regulation enables the sets to pick up relatively large motor loads with a minimum of light flicker and voltage drop. They are designed to be operated by personnel without special training. There are only three operating adjustments on the engines, and none of these involve the fuel system. The generators are direct-connected, rotating field type, available as 3-phase or single phase, 60-cycle or 50-cycle, and with a wide variety of voltages.



New Caterpillar Diesel Electric Set



The New Heltzel Heavy-Duty Steel Forms for constructing combined curb-and-gutters. Face forms are removed without disturbing the front and back forms or the division plates — greatly facilitating the hand finishing operations on the face curb. Quick easy adjustments for setting to line and grade. Write today for complete information or quotations and catalog S-20.

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FINISHING TOOLS FOR CONCRETE ROADS

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New Trucks

In addition to the model LM truck and the model LMT tractor recently announced, Mack Trucks, Inc., Long Island City, N. J., now announces production of a new series of truck, tractor, and 6-wheel models designed expressly for heavy hauling. Included in this new series of models now in production are two truck models, the LF and the LJ. Mack is also offering three new tractor models designed exclusively for tractor service: the model LFT; the LHT, particularly designed for the hauling of heavy train loads; and the LJT. Rounding out this new series of Mack models are three new Mack 6-wheelers, the model LF 6-wheeler, the LH 6-wheeler, and the model LM 6-wheeler. These new Mack truck and 6-wheel models are offered in a variety of wheelbase lengths, while the tractor models, besides their standard wheelbase length are available in a special wheelbase length for sleeper cabs.

Mack Model LF Truck

New Lightweight 60 Cu. Ft. Compressor

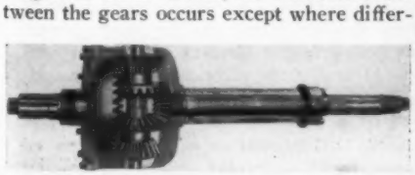
A new 2-stage air-cooled compressor that delivers 60 cu. ft. of free air per minute at a discharge pressure of 100 lb. has been introduced by the Ingersoll-Rand Co., 11 Broadway, New York City. Three new types of mountings are available, all built around the same gasoline engine-compressor plant. The Push-about is mounted on roller-bearing, pneumatic-tired wheels. It is well balanced and can be easily rolled on and off a truck. One man can handle it on

Push-About Compressor

the ground. A turtle-back cover protects the compressor and engine from the weather and provides a means of locking the wheels against theft. The De Luxe Model is a spring-mounted, high-speed trailer unit with tool boxes for carrying equipment built into the sides of the body. The Utility Model is mounted on a steel base and can be mounted directly on a service truck or built into the body. Electric starting is available on the Utility and De Luxe mountings only.

New Power Proportioning Differential for 6-Wheel Trucks

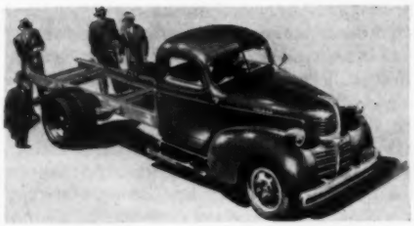
A new power proportioning differential especially designed for six-wheel drive trucks has been announced by H. B. Dodge, Chief Engineer of The Four Wheel Drive Auto Co., of Clintonville, Wisc., FWD truck manufacturers. The new power proportioning differential is used in the power line of 6-wheel-drive trucks and distributes the driving power to each axle in direct proportion to their normal loaded weight. The new differential provides full differential action between the driving axles of the truck. The basic principle of the new power proportioning differential is similar to the common differential that divides the power equally. In the new FWD differential, however, the side gears have unequal radii, and the differential pinion gears are arranged to meet the unequal sized side gears. The ratio between the pinion and side gears operate as a continuous lever in such a manner that the same force applied on the shorter leverage of the differential side gear connected to the front axle reduces the torque applied to that axle while the same force applied to the rear leverage of the larger side gear connected to the rear bogie increases the torque to the two driving axles of the bogie. In the new FWD differential the gearing is arranged so that a 4 to 1 ratio is obtained. Since the balance secured is by gearing, it provides a continuous leverage. In other words, no movement between the gears occurs except where differential action occurs such as is the case in rounding corners, going over uneven ground or the like.



Phantom View of New Power Proportioning Center Differential for FWD Six-Wheel-Drive Trucks

New Heavy-Duty Diesel Truck

Important mechanical improvements and numerous changes to provide increased comfort and safety are incorporated in the heavy-duty Dodge diesel truck for 1941, which retains all the proved Diesel-power features of the 1939 and 1940 models. An important mechanical improvement on the 1941 models is an auxiliary 6-volt generator to operate all lights (both truck and trailer), instruments and new dual horns. The auxiliary generator combined with "Sealed-Beam" headlights, also new for 1941, result in improved lighting and greater safety. The 24-volt primary generator and 24-volt starting motor assure fast starting under all-weather conditions. The cooling system has been improved for effective operation in tropical climates and includes



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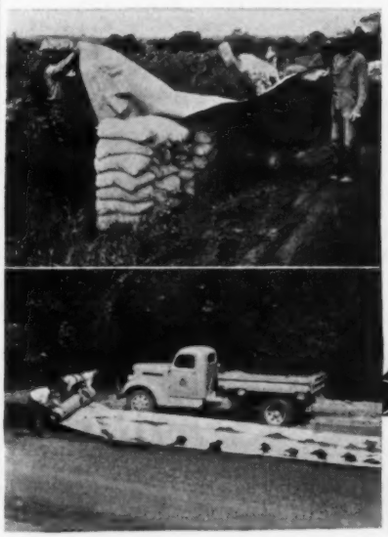

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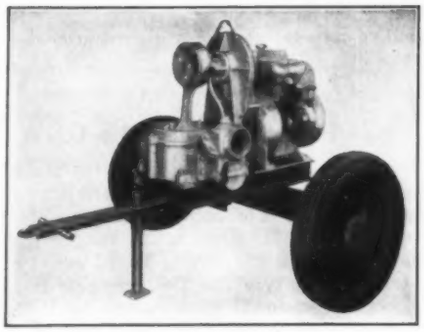
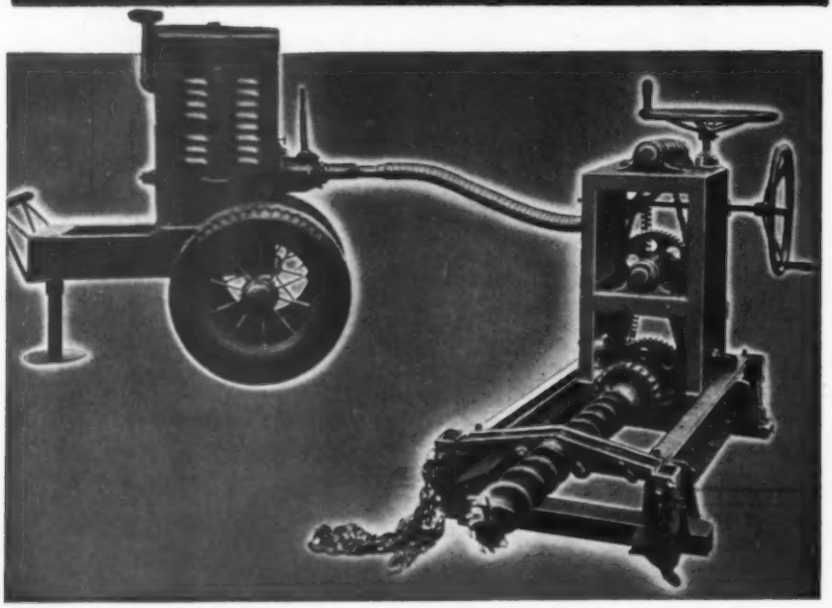
New Utility Pump

A new utility pump—a diaphragm pump mounted on a high-speed, spring-mounted trailer with pneumatic tires—has been added to the line of the Novo Engine Co., Lansing, Mich. It is made in two models, the capacities at 10 ft. suction left being: 3 in. pump, 3,000 GPH(AGC Rating); 4 in. pump, 6,000 GPH (AGC Rating). The trailer is equipped with coil springs mounted out close to the wheels, thereby placing a minimum load on the axle itself and at the same time preventing bucking and swaying and top heaviness. This mounting further permits carrying the load very low which results in greater stability. A heavy rubber bumper eliminates all shock due to rebound. This trailer has a standard automobile tread and is available on self-priming centrifugal pumps, including the 4 in. size.



New Novo Utility Pump

Parmanco
HORIZONTAL DRILLS



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That cutting pavements causes more damage than traffic.
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PARMANCO Utility Drills are made in two sizes, PARMANCO JUNIOR for drilling 4 inch holes up to 50 feet, and the PARMANCO GENERAL UTILITY for drilling longer distances or drilling larger holes.
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New Rock Drill Mounting

A new air-feed rock drill mounting, designed for use with Ingersoll-Rand Jackhamers, that helps to support the drill, absorb the recoil and feed it forward as the hole is drilled, has been announced by the Ingersoll-Rand Co., 11 Broadway, New York City. This new mounting is known as the Jackleg, and it is stated that with it the larger and faster drilling Jackhamers can now be used on horizontal holes. Instead of the operator holding up the drill by hand and pushing it forward as it drills into the rock, he uses the jackleg and only has to exert a slight downward pull on the handle of the Jackhamer to balance the lifting force that is exerted by the pneumatic feed of the Jackleg. The Jackleg weighs only 35 lbs. and can be easily regulated by a conveniently located pressure throttle.

Jackleg in Operation with Jackhammer

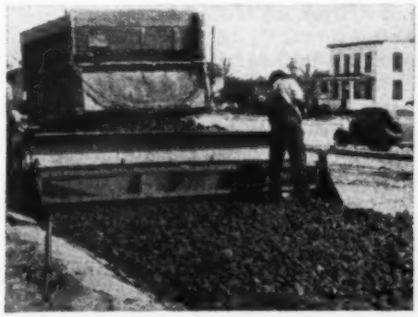
Nut Has New Locking Principle

A locking nut that can be tightened up or backed off part way, years after its application, and still retain its grip on the bolt, has been placed on the market by Security Metal Products, Inc., 303 East Kalamazoo Ave., Kalamazoo, Mich. The nut can be taken off and reapplied many times without losing its gripping power. The bolt gripping element of the nut consists of a slightly elliptical shaped spring-steel retainer permanently seated in the head of a standard nut. When the nut is applied, the retainer is distorted from an elliptical into a circular shape, thus setting up a powerful spring pressure between the bolt threads and the retainer threads. Neither the threads of the bolt nor of the

retainer are injured when applying or removing. This nut is started on the bolt with the fingers, just like a common nut, and a wrench is used when the threads of the retainer start to engage the threads on the bolt. It fully meets thread-pitch tolerances of the National Screw Thread Commission.

New Strike-off for Attachment to Spreader

The Buckeye Traction Ditcher Company, Findlay, Ohio, anonunces the development of a strike-off attachment for use with its spreader. This attachment consists of a blade amounted on skids which is attached to the spreader box proper and dragged along behind it. This unit permits spreading of base courses from two to six inches



Buckeye Spreader and Strike-off in Operation

in depth. The blade is easily adjustable by means of hand cranks at each end. When operating this unit, the feed roll is removed from the spreader, leaving a full opening for discharge to the road ahead of the strike-off blade.

New Trucks

The White Motor Co., Cleveland, O., has announced the extension of its super power truck line. Super power is now available in a full balanced line of motor trucks which includes units from 1½ tons upward in both conventional and cab-over-engine types. Straight trucks, tractors and six wheelers are all found in the comprehensive list of models. Four basic super power engines, all in the 6-cylinder class, are being produced to take care of White's new truck line.

Conventional Chassis for New White Truck

Specifications are as follows: Model 100A—90 h.p., 3-7/16 in. bore, 4½ in. stroke, 250 cu. in. displacement, compression ratio 6.75 to 1; Model 110A—100 h.p., 3-9/16 in. bore, 4½ in. stroke, 270 cu. in. displacement, compression ratio 6.5 to 1; Model 120A—110 h.p., 3⅜ in. bore, 4½ in. stroke, 318 cu. in. displacement, compression ratio 6.4 to 1; Model 140A—125 h.p., 3⅜ in. bore, 5⅛ in. stroke, 362 cu. in. displacement, compression ratio 6.28 to 1.

New Diesel Engine

A new 4-cylinder 60 h.p. automotive diesel engine, the model D312, has been added to the line of the Caterpillar Tractor Co., Peoria, Ill. The engine is a 4-stroke, valve-in-head, water cooled model with a bore of 4¼ in. and a stroke of 5½ in. Maximum horsepower is developed at 1800 r.p.m., and a maximum torque of 193 lb. ft. at 1200 r.p.m. Piston displacement is 312 cu. in. Pistons in the Model D312 are of aluminum alloy. The block, cylinder head and crankcase unit are in cast alloy iron. There are five main crankshaft bearings, with a total surface of 89.5 sq. in. Crank pin bearings are 2⅝ in. in diameter and 1⅞ in. in length. There is a crankshaft torsional vibration damper. Water circulation is by pump, with the operating temperature of the water controlled by thermostat. There is an air-cooled type lubricating oil cooler provided. Pressure lubrication is provided to all main and crank pin bearings, camshaft bearings, valve operating mechanism and timing gears. The engine fuel system is manufactured by Caterpillar Tractor Co., and features solid injection into precombustion chambers. There is an individual pump and valve for each cylinder; and the system is factory set, requiring no adjustment in the field. For replacement installations, "Caterpillar's" Model D312 engine is offered as a complete unit, equipped with a 5-speed Spice No. 2553 transmission and 13-in. single plate clutch.

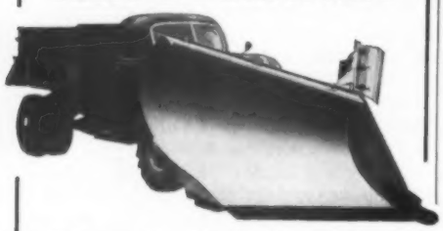
1941 MARMON-HERRINGTON
THE WORLD'S BIGGEST BARGAIN
IN *All-Wheel-Drive* TRUCKS

● Here's a truck for really "tough going"—at a price you can afford to pay. A truck that will take full loads through mud, sand or snow, that would stall an "ordinary" truck. A truck with gross capacities up to 22,000 lbs. that is as maneuverable and as speedy on the highway as a passenger car. One that has all the inherent stamina and economy of the standard Ford truck, but endowed with tractive power that is practically doubled for the unusual jobs other trucks can't do.

The new 1941 Marmon-Herrington *All-Wheel-Drive* converted Fords are now ready. They are the only light and medium weight *All-Wheel-Drive* vehicles on the market with years of practical experience, and all-wheel-drive engineering skill behind them. All models, including trucks, commercial cars and passenger cars are available at prices that are remarkably low. Write for literature or request an on-the-job demonstration. You'll be surprised! Cable address MARTON.

MARMON-HERRINGTON COMPANY, INC.
INDIANAPOLIS, INDIANA, U.S.A.

There's a Difference



Between "bulldozing" and plowing snow; bulldozing is merely pushing the snow which takes plenty of power, while plowing snow picks it up and rolls it. That is why Ross PLOWS with "Sno-Flo" moldboards will move more snow with fifty percent less power.

Ross plows have gained an enviable reputation in the snow belts of the United States and Canada because of operating efficiency.

Ross plows and wings are available for all trucks and tractors.

Manufactured by

THE BURCH CORPORATION
Crestline, Ohio

Builders of Equipment for Fifty Years

NOVO BREAKER

PAVEMENT
Demolishing
Trimming &
Cutting

BREAKING

The results obtained with the Novo Breaker in breaking up pavements, bridge floors, drives, curbs, etc., have proved beyond a doubt that here is the fastest, cheapest breaking method.

CUTTING

Hammer equipped with shearing knife is used for trench work, cutting without breakback in reinforced concrete. Also used in frost & trimming.

COSTS

Let us tell you the surprisingly low cost figure at which pavements can be broken by this method. It mounts on your truck. Send for information.

NOVO ENGINE COMPANY
LANSING, MICHIGAN

246 PORTER ST.

Send literature and prices on the NOVO Pavement Breaker.

Name .....
Address .....
City ..... **State** .....

Barricade Frames

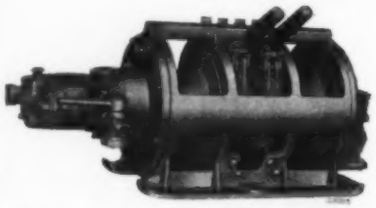
The road barricade here illustrated consists of a board securely held in the toothed jaws of two pairs of folding steel legs. These legs, recently developed by Wagner Manufacturing Co., Cedar Falls,

Wagner Folding Sawhorse Legs

Iowa, are designed especially for convenience in transport, and may be carried in the trunk or back seat of an ordinary passenger car. They are available in 24-in. and 30-in. lengths, the former weighing 12½ lbs. and the latter 15½ lbs. per pair. The manufacturer refers to the units as "sawhorse legs," and offers them for every sort of sawhorse use.

New Scraper Hoist

A new scraper hoist weighing only 250 lb. (without cable guides) and compact enough to be passed through an opening 13 in. x 15 in. has been added to the line of Ingersoll-Rand Co., 11 Broadway, New York, N. Y. It has a cable pull of 650 to 1,000 lb. and a cable pull of 125 to 150 ft. per minute. Either air or electric drive is

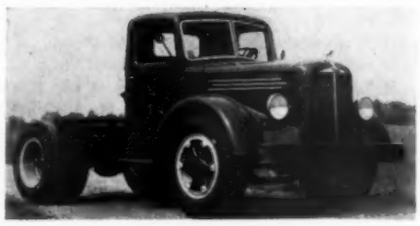


Air-Motor Driven Lightweight Double-Drum Scraper Hoist

available. The air motor is an Ingersoll-Rand "Multi-Vane" type with a governor which limits the free speed and conserves air. Construction details include: An individual clutch lever control for each drum. No tools are required to make a clutch adjustment which is external and easily made by hand. All gears are totally enclosed and operate in a grease bath. Anti-friction bearings support all rotating parts. Helical stub tooth gears provide smooth, quiet operation.

New Tractor Unit

A unit designed expressly for tractor service has been placed in production by Mack Trucks, Inc., Long Island City, N. Y. This new tractor Model LMT is built to haul a maximum gross train weight of 60,000 lb. It is offered in the standard wheelbase length of 140 in. Standard equipment on the LMT includes, among other items, double-acting hydraulic shock absorbers on front, airbrakes, semi-trailer brake, and electric connections. The LMT is powered by the 6-cylinder model EP Mack Thermodyne engine with 4¾ in by 5¾ in. bore and stroke developing 160 h.p. at governed speed of 2100 r.p.m. Total piston displacement of this engine is 611 cu. in. Torque developed is 462 lb.-ft. at 600 r.p.m. In place of this Mack EP engine which is standard in the LMT, Mack is also offering, at extra charge, the larger model EY Mack Thermodyne engine of 707 cu. in. piston displacement, an engine which develops 175 h.p. at governed speed of 2000 r.p.m.



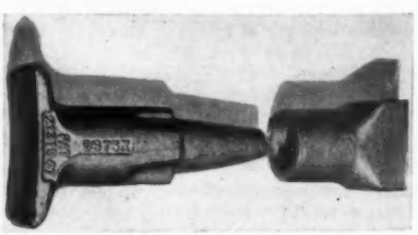
New Mack Tractor

New Heavy Duty Emergency Jack

An emergency jack having a full 20-ton lifting and holding capacity on either the cap or toe lift of the jack has been added to the line of Templeton, Kenly & Co., Chicago, Ill. The jack is 30 in. high, has a full 17¾ in. lift and weighs 167 lb. with complete equipment. Besides lifting on cap and toe, it lifts on the auxiliary shoe which hooks into the cap or on the chain with grab hook end. any link of which can be engaged with the recess in the cap. Besides lifting and lowering vertically, this jack tilts on its base for jacking at an angle. The tilting pawl can be released by the operator's toe. The jack can be used horizontally for pushing, spreading or pulling by using the chain.

New Steel Tip for Tampers

A two-piece cast steel tip for tampers has been announced by Los Angeles Steel Casting Co., Los Angeles, Calif. Bases are made of special nickel steel that has excellent welding qualities and great strength. Tips are made of chrome molybdenum steel to resist abrasion. The long tapered shank on the base provides ample surface contact with the socket of the tip. A flat register in the socket engages with a flat area on the shank and prevents the tip from turning. After the bases are welded onto the tamper drum, subsequent cutting and welding are entirely eliminated. When replacements are needed, the worn tips are driven off and new tips are driven on. Renewals can be made in the field, on the job, without expensive equipment.



"Tamprite" Tip

WITH THE MANUFACTURERS

Chain Belt Moves Minneapolis Office

Chain Belt Co., Milwaukee, Wis., has removed its Minneapolis office from 808 La Salle Ave. to 1645 Hennepin Ave. At the new address the company will have a much larger space and increased service facilities. R. X. Raymond, who has been associated with the Chain Belt Co. for over 20 years, is Minneapolis District Manager.

Heil Announces Complete Line of Equipment for Cletrac Crawler Tractors

A premier showing of their complete line of tractor earth moving equipment has been held by the Heil Co., Milwaukee, Wis., at the Cleveland Tractor Co.'s factory at Cleveland. O. One hundred fifty Cletrac

A Group of Heil Men at the Demonstration: Left to Right—Hank French, in Charge of Engineering, Road Machinery Division; Jack Davies, Southern District Manager, and Joe Heil, Executive Vice-President

distributors assembled in Cleveland, and Joseph Hill, Executive Vice-President, of the Heil Company; T. A. Miller, Sales Manager of the Road Machinery Division; Henry French, Chief Engineer of the Road Machinery Division, and the various district managers of the Heil Company, explained the design, construction, and the many mechanical features embodied in this new, full line of machinery available exclusively for use with Cletrac Crawler Tractors. In addition, advertising, merchandising, and sales promotion plans were discussed and explained in detail. An entire morning was given over to formal discussions of these various items. An entire afternoon was given over to demonstration of the 26 pieces of equipment and tractors in the Cletrac demonstration field. Here the distributors had an opportunity to see what this $70,000 worth of equipment could do.

Sterling Pump Acquires Roots-Connersville Blower Turbine Pump Division!

Sterling Pump Corporation, Hamilton, O., manufacturers of deep well turbine and centrifugal pumping units, has acquired the Turbine Pump Division of the Roots-Connersville Blower Corp. of Connersville, Ind. A transfer of inventory has already been made from Connersville, Ind., to Hamilton, O., and all former Roots-Connersville installations will now be serviced, if and when necessary, by an enlarged staff of Sterling engineers available from coast to coast. Henry J. McKenzie, Executive Vice-President and General Manager of Sterling Pump Corporation, has been appointed president of that corporation to succeed Maurice Rothschild, who will continue as a director. Mr. McKenzie, who also retains his duties of General Manager in addition to those of President, has long been identified with and is an outstanding and well-known personality in the pump industry. Starting in 1917 in the engineering department of Layne & Bowler Corp., Los Angeles, Mr. McKenzie rose successively through the positions of district manager, general manager and sales manager at Memphis, Tenn., then was appointed general manager and vice-president of this organization. Later, Mr. McKenzie left Layne & Bowler to become manager of the Turbine Pump Division of Worthington Pump & Machinery Corp. at the Holyoke, Mass., plant.

H. O. Penn Adopts Employee Pension Plan to Bolster Social Security Benefits

H. O. Penn Machinery Co. of New York, Mineola and Poughkeepsie, N. Y., has adopted a pension plan similar to and supplementary to the Social Security Act which provides Federal pensions for industrial employees retiring after 1941. The plan provides for the payment to the employee, upon reaching the age of 65, the equivalent of four years' salary which is applied to the purchase of monthly income for the life of the employee,—in most cases equal to about 40 per cent of the salaries now enjoyed. Employees also receive approximately one full year's salary in cash at the age of 65 for emergency purposes. Upon the death of an employee, his widow receives about 70 per cent of four years' salary as a minimum amount. The Penn pension idea is a cooperative arrangement which is said to be one of the most complete and carefully worked out plans in existence. Employees make contributions from wages but the company actually purchases more than half of the pensions for those who remain in service to retirement. Richard A. Jones & Son of New York City assisted in arranging the details of the new plan acting as brokers.

Testing Company Installs New Salt Spray Chamber

The United States Testing Co., Hoboken, N. J., has just completed installation of a salt spray chamber at its main laboratories in Hoboken, N. J., to test the corrosion resisting properties of ferrous and non-ferrous metals. The chamber has been designed to test materials against A.S.T.M. and Federal Specifications. The apparatus contains a thermostatically controlled heating element for conducting the tests at elevated temperatures. The compressed air supplied to the nozzle is previously saturated with the standard salt solution and thoroughly cleaned to insure freedom from oil and dirt. The complete unit is automatically controlled. The construction of

● This statement came from a crane operator who for 25 years has worked with all types of buckets. The bucket which won his praise is a ¾ yard Multiple Rope Williams Bucket used by F. F. Mengel Company, Wisconsin Rapids.

The men at the controls know how Williams Buckets can help make time in digging and hoving yardage. The men in the "front office" know how Williams Buckets stack up in long service and low maintenance cost.

They're "Built to Last, and Move Dirt Fast"

THE WELLMAN ENGINEERING CO.
7003 Central Avenue, Cleveland, Ohio

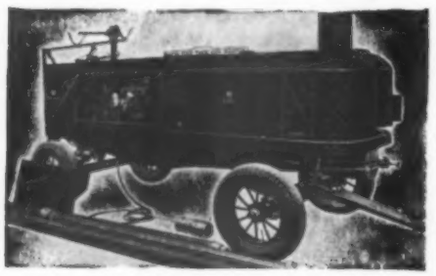
Bulletins describing all types of Williams Buckets sent free on request

Now . . . WELDED Rolled Steel Construction

WILLIAMS *Buckets*
***built by* WELLMAN**

GRACE
2-WAY AXLE DRIVEN SWEEPER

RAPID FIRE HEATER



- *Grace 2-Way Axle Driven Sweeper*—the modern traction driven sweeper that successfully meets every problem of any contractor.
- *Rapid Fire Heater*—A fast-pumping, fast-heat circulating heater that heats 10,000-gallon insulated cars at 50° per hour. Write for detailed information and prices.

W. E. GRACE MFG. CO. 6000 Holmes St. DALLAS

Reliance—
CRUSHING
SCREENING and
WASHING UNITS

● UP TO 2000 TONS A DAY ●

Crushers	Bins	Drag-Lines
Elevators	Pulverizers	"GAYCO"
Screens	Feeders	Centrifugal
Sweepers	Spreaders	Air Separa-
Wash Boxes	Kettles	tors
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Kingston, N. Y.
Canadian Representatives: F. H. Hopkins & Co., Ltd.
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MASTER
WORKMAN

For Better Roads, put a WORKMAN Machine on the job. 3 sizes:
THE GENERAL • THE SUPER
THE MASTER

YORK MODERN CORPORATION
UNADILLA, NEW YORK

the chamber is such that a finely divided mist or fog is obtained and no condensation from the top falls on the specimens. The size of the chamber is extra large so that all sizes of samples can be tested from small test specimens to full size commercial products.

Marion Apoints New Manager of Chicago District

The Marion Steam Shovel Co., Marion, O., has announced the appointment of D. E. Rizor as manager of the Chicago district to replace John L. Steward, who has resigned. Mr. Rizor is thoroughly familiar with the district, having spent considerable time on a previous occasion working out of the Chicago office.

A. J. Nydick Appointed Executive Secretary of A. C. C. L.

The American Council of Commercial Laboratories has announced the appointment of A. J. Nydick to the office of executive secretary. The Council, which was organized back in 1937, is made up of testing and research laboratories located throughout the country. The A.C.C.L. was formed by the laboratories to serve as a clearing house for the dissemination of scientific and testing research information to its various members and to serve as a control board in the maintenance of high standard professional ethics in the fields of testing and research. Mr. Nydick is associated with Garey and Garey, Esqs., at 63 Wall Street, New York City. Mr. Nydick is representative in Pennsylvania for the American Chemical Society and serves as general counsel for the Pennsylvania Chemical Society and is, therefore, well versed in the industrial and consumer fields with which the Council is associated.

Chicago Pneumatic Appointments

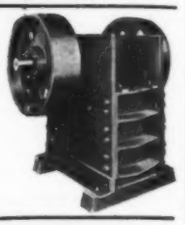
Chicago Pneumatic Tool Co., 6 East 42nd St., New York City, announces the appointment of P. J. Christy as manager of their Philadelphia, Pa., office, effective Aug. 1, 1940. He succeeds A. M. Brown who has been transferred to Washington, D. C., as manager of the new branch recently opened there. The company also announces the appointment of C. A. Diehl as manager of the Houston, Tex., office.

NEW LITERATURE

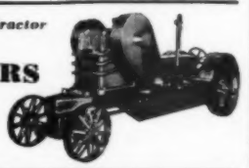
Piston Ring Handbook—A useful and timely book for engineers and operators, covering various piston ring problems encountered in the operation of internal combustion engines, steam engines, compressors and pumps, together with recommendations for piston ring applications designed to overcome various operating difficulties, has been prepared by the Engineering Department, Double Seal Ring Co., Fort Worth, Tex. The book is fully illustrated and contains a considerable amount of important engineering data and practical information, including tables and reference data for the engineer and operator.

"Established in 1885"
ROADS whether mountain or farm to market under any condition
you can depend on
GRUENDLER EQUIPMENT
(FREE—Write for our 16 page Catalog and Specifications)

JAW CRUSHERS
Bronze or Roller Bearing
Heavy armor plate steel or cast steel.
Heavy Duty Construction
Large capacity
Small power Requirements



Self Traveling Tractor
JAW CRUSHERS
Ideal for maintenance road work



Stationary or Portable
LIMESTONE CRUSHERS
Wide crushing range, crushes stone 2½" down to agriculture dust.
Ideal for Farm to Market Road Work

Portable 2 in 1 Hammer Crushers

GRUENDLER
CRUSHER & PULVERIZER CO.
2921-29 N. Market St., St. Louis, Mo.

HUSTLE WITHOUT BUSTLE

We're hustlers when the occasion demands but we don't make any noise about it. Our service is as cheerful and quiet as it is speedy.

Emil Eitel
Karl Eitel
Roy Steffen

BISMARCK
HOTEL-CHICAGO
RANDOLPH AND LA SALLE

Dragline Bucket—A new booklet describing the new P&H "Biglode" dragline bucket recently placed on the market by the Harnischfeger Corporation, Milwaukee, Wis., has just been issued by the company. The booklet, known as Bulletin D-9, illustrates with photographs and diagrams such features of the "Biglode" bucket as the welded alloy steel construction, simplified design, cable replacement system and flared lip and reversible teeth assembly.

Small Scrapers— Small Scrapers, their applications and advantages are described and extensively illustrated in a new small Carryall folder released by R. G. LeTourneau, Inc., of Peoria, Ill. The six-page, two-color folder deals with carryalls in sizes from 3 to 11 yd. heaped measure, stressing their use both as utility units and tools to handle the entire job. Design features and efficient scraper use are also covered.

1¼ Yd. Shovel—Catalog 65-C describing and illustrating their heavy-duty 1¼-yd. convertible shovel with 20-ton crane rating has been released by Bay City Shovels, Inc., Bay City, Mich. It contains 12 pages of essential information, including complete specifications, working ranges for shovel, dragline and trench-hoe and crane ratings at various boom radii. Catalog is profusely illustrated with job pictures ranging from common excavation to steel erection.

Scrapers—A new fully-illustrated bulletin describing the new Bucyrus-Erie 4-wheel scrapers has just been issued by Bucyrus-Erie Co., South Milwaukee, Wis. This 24-page booklet, attractively printed in two colors, describes in detail the features incorporated in these new scrapers. In addition, the new Bucyrus-Erie power control units are illustrated and dscribed. The bulletin concludes with a table of complete specifications on the four sizes of 4-wheel scrapers offered and illustrations of all the various machines in the complete Bucyrus-Erie tractor equipment line.

Truck Crane—Bay City Shovels, Inc., Bay City, Mich., have recently issued a new 12-page Catalog 18-B describing and illustrating their heavy-duty truck crane. Catalog reviews sturdy machinery design and assembly, illustrating the unit cast alloy steel revolving table and a typical base frame with cast roller path and heavy-duty outriggers. Detailed specifications, shovel working ranges and crane safe loads at various radii up to 55 ft. are included.

Suction Hose—The B. F. Goodrich Co., Akron, O., has issued a new 4-page catalog section on its line of suction hose. The leaflet describes the type of construction on all types of suction hose, whether rough or smooth bore, light or heavy wall. Approximate data are given on the different sizes, net weight pounds per foot, standard length of blank ends and overall outside dimension. These are listed for each type of hose, as well as description of fittings used with the hose.

"Off the Highway" Tires—In step with the increasing use of pneumatic rubber tires in earthmoving, road-building and general contracting service, The B. F. Goodrich Co., Akron, O., has published a handy reference book on these specialized tires. Written for contractors and other users of "off-the highway" tires, the booklet furnishes data and information on these super-traction tires including a quick-check chart showing types of service and typical applications.

Concrete Carts—The Ransome Concrete Machinery Co., Dunellen, N. J., has issued Bulletin No. 163-A on their line of Concrete Carts. It is entitled "Speed Up Moving of Concrete." It is 8½ in. by 11 in., two colors and profusely illustrated.

½ Yd. Shovel—A new 12-page catalog issued by Bay City Shovels, Inc., Bay City, Mich., illustrates and describes their ½ yd. Model 25. Working ranges for shovel, dragline and trench hoe are reviewed in detail and crane ratings at various radii are given for this 5-ton crane.

Crane — The General Excavator Co., Marion, O., has issued a 12-page bulletin dealing with its new wheel mounted crane. Chapter headings include: Lifting Capacity, Mobility, Maneuverability, and Stability. The essential facts under each heading are summed up in condensed "Quickfact Summaries."

Portable Compressors—A comprehensive bulletin has been issued by the Chicago Pneumatic Tool Co., 6 East 44th St., New York City, covering its complete line of portable compressors of streamlined design. Outstanding features of these newly designed compressors are illustrated and described and tables of specifications and weights and dimensions are given. Included in the bulletin are illustrations and specifications and a description of a new 500 cu. ft. diesel driven portable compressor.

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New or Rebuilt
Sale or Rent

We will trade in your old instruments, buy them for cash or make complete and economical repairs, any make. Your instruments deserve factory service. For information ask for New List RS-510.

WARREN-KNIGHT CO.
Manufacturers of Sterling Transits and Levels
136 No. 12th St. Philadelphia, Penna.

Used Equipment for Sale

12'x12'x20' high oversize hopper, sloping grizzly
20' and 32' bucket elevators
30" x 10'0" shaker screen
Model No. U-40 Allis Chalmers engine
4" Sterling sand pump No. 3558
60" x 20' Revolving screen—structural frame, portable
10" x 20"—10" x 36" & 15" x 36" Diamond Roller Bearing Jaw Crushers

New Equipment

9" x 16" Diamond crusher—truck mounted with engine
No. 20 Diamond portable crushing and screening plant
2—16" x 20" portable crushing and elevating plants
Special prices for quick sale

DIAMOND IRON WORKS, INC. AND MAHR MANUFACTURING CO. DIV.
Minneapolis, Minnesota

WANTED—MUNICIPAL EQUIPMENT SALES AGENTS

To sell on liberal commission basis—Street Signs, Traffic Signs, Reflector Signs, Signals, Parking Meters, etc.

MUNICIPAL STREET SIGN CO.
777 Meeker Ave. Brooklyn, N. Y.

LOCOMOTIVES FOR SALE

One Standard gauge 2-6-0 Type locomotive, maximum tractive power 22,800 lbs., soft coal burning boiler, tested 180 lb. pressure.
One Standard gauge 0-6-0 Type switching engine, tractive power 28,700 lbs., soft coal burning boiler, tested 180 lb. pressure.
Both excellent condition. If interested, please write for specifications and price.
Box 816, Roads and Streets, 330 South Wells Street Chicago, Ill.

FOR SALE

Barber-Green Model 848—Heavy Duty **—Bituminous Mixer For Central Plant or Travel Plant Operation.** Excellent Condition—Used for only 20,000 tons of mix laid in fall of 1938—Location Flushing, N. Y.

DIPMIX CORPORATION
Mineola, N. Y.

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CHARLES EVAN FOWLER
MOST NOTABLE BOOK ON BASIC DESIGN
300 Pages—300 Illustrations—$4.00 Post Pd.
For clubs 10 or more special rates.
THIRD THOUSAND. Red leatherette—gold top.
GILLETTE PUBLISHING CO.
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